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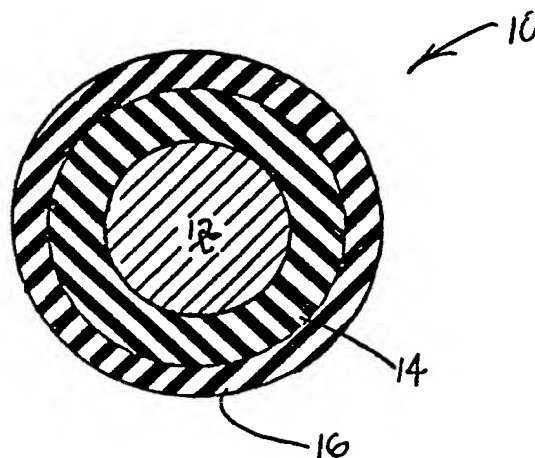
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(54) Title: PULSED VOLTAGE SURGE RESISTANT MAGNET WIRE

(57) Abstract

A pulsed voltage surge resistant magnet wire (18) comprising a conductor (12), a continuous and concentric and flexible uniform coat of base material (14) superimposed on the conductor (12). The shield (16) has therein an effective amount of a particulate material. The shield (16) may be superimposed on the coat of base insulation material (14), and may have a continuous and concentric and flexible and uniform top coat of insulation material (20) superimposed thereon.



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## PULSED VOLTAGE SURGE RESISTANT MAGNET WIRE

## Background Of The Invention

5       The present invention relates to an improved magnet wire, and more particularly, to an improved magnet wire which is highly resistant to repetitive or pulsed, high voltage spikes or surges.

10       Much has been written over the years about various types of variable frequency or pulse-width modulated (PWM) and/or inverter adjustable speed drives on AC motors and their affect on motor operation. PWM drives are known to have significant harmonics and transients which may alter the motor performance characteristics and life expectancy. The effects of maximum voltage, rate of rise, switching frequencies, resonances and harmonics have all been identified.

15       The PWM inverter is one of the newest and fastest evolving technologies in non-linear devices used in motor drive systems. The motivation for using PWM inverters is speed control of an AC motor comparable to the prior mechanical or DC adjustable speed drives without loss of torque. With the increased emphasis of energy conservation and lower cost, the use of higher performance PWM drives has grown at an exponential rate. However, it has been found that these PWM drives  
20       cause premature failure of the magnet wire insulation systems used in such AC motors.

      It is therefore highly desirable to provide an improved magnet wire for use in AC motors having variable frequency or PWM and/or inverter drives.

25       It is also highly desirable to provide an improved magnet wire which has increased resistance to insulation degradation caused by pulsed voltage surges.

      The basic stresses acting upon the stator and rotor windings can be broken down into thermal stresses, mechanical stresses, dielectrical stresses and environmental stresses. All of these stresses are impacted by voltage, voltage wave forms and frequencies, in that the longevity of the winding is predicated upon the  
30       integrity of the whole insulation system. During the early stages of applying various voltages, voltage wave forms and frequencies to AC motors, the major focus was on the thermal stress generated by the unwanted drive harmonics passing through to the motor and the associated heating. The other critical factor dealt with the increased heating caused by reduced cooling capacity at slower speeds.  
35       While more attention was given initially to rotor bar shapes than to stator insu-

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lation voltage withstand capability, the present drive technology, which uses much higher switching rates (sometimes referred to as carrier frequencies) requires the focus to involve both the stator winding system and the rotor winding system.

The standard magnet wire used by most motor manufacturers is typically class H magnet wire. In accordance with the ANSI/NEMA magnet wire standard (ANSI/NEMA MW 1000-1993), this wire, under ideal conditions (twisted wire pair tests) is capable of a withstand voltage of 5,700 volts at a rise time not to exceed 500 volts per second. However, it has been found that utilizing current drive technology, a magnet wire may have to withstand voltage surges approaching 3,000 volts, voltage rises from about 1.0 kV per microsecond to about 100 kV per microsecond, frequencies from about 1 kHz to about 20 kHz, and temperatures for short periods of time approaching 300°C. It has also been found that in certain circumstances, a surge is reflected so as to reinforce a primary surge wave voltage at succeeding coils to produce front times exceeding 3 micro seconds in subsequent coils.

These values are based upon the assumption that the wire film is applied concentrically to the conductor and that no appreciation of film thickness occurs in the manufacturing process or operation of the motor at high operating temperatures or that turn to turn bond strength may decrease significantly. Hence, coil movement and abrasion that reduce the thickness of the turn insulation over time can cause premature failure of the turn insulation.

Therefore, it is highly desirable to provide an improved magnet wire which can withstand voltage surges approaching 3,000 volts having rise times of less than 100 kV per micro second and temperature rises to 300°C., frequencies of less than 20 kHz after the insertion of the windings in a motor rotor and stator at normal operating temperatures over the anticipated lifetime of the motor.

It is also highly desirable to provide an improved magnet wire which will pass the ANSI/NEMA magnet wire standards MW1000 and in addition ANSI/NEMA MG1-Parts 30 and 31 being developed for constant speed motors on a sinusoidal bus and general purpose induction motors used with variable frequency controls, or both, and definite purpose inverter fed motors, respectively.

A number of investigations to determine more accurately the voltage endurance levels of the present proposed insulation systems preliminarily indicate that the transient voltage levels combined with the operating temperatures of such motors can exceed corona starting levels. Some have blamed corona for the



insulation failures in motors having variable frequency, PWM and/or inverter drives. Others have discounted corona as the culprit inasmuch as failure occurred in portions of the winding where the electrical field is low. While it is known that conventional enamels degrade when exposed to high voltage corona discharge, and that corona is discharged between adjacent windings of motor insulation, due to the inevitable voids and the high voltage ionization of air in the voids of the motor stator and rotor insulation windings, it has been found that insulation failure of motors driven by variable frequency, PWM and/or inverter drives is not primarily a corona insulation degradation mechanism.

Corona aging and magnet wire failure conditions may be distinguished from pulsed voltage surge aging and magnet wire failure conditions. Corona aging conditions occur in the presence of a gas (usually air in magnet wire windings) at positions of localized high electrical stress (AC or DC), that is strong enough to break down or ionize the gas, to produce electron or ion energy strong enough to break down polymer chains or to create ionic radicals via chemical reactions. The chemical reactions result in polymer degradation. Corona discharge is a relatively "cold discharge" and temperature is usually not a substantial factor. Magnet wire aging/failure due to corona is usually a long-term process.

In contrast, pulsed voltage surge aging and magnet wire failure does not require the presence of a gas media. Pulsed voltage surge failure instead requires repetitive or pulsed voltage surges having relatively short rise times, or high voltage to rise time ratios, relatively high frequency of pulse and relatively high impulse energy, and occurs in relatively high temperatures generated thereby. Given high voltages and minimum rise times, pulsed voltage surge failure can occur relatively quickly, and is believed to be the predominant cause of failure in variable frequency, PWM, and/or inverter driven motors.

It is therefore highly desirable to provide an improved magnet wire which meets all of the performance characteristics desired by motor manufacturers for stator and rotor windings for use under corona discharge conditions.

Finally, it is also highly desirable to provide an improved magnet wire which possesses all of the above-identified features.

#### Summary Of The Invention

It is therefore an object of the invention to provide an improved magnet wire for use in AC motors having variable frequency or PWM and/or inverter drives.

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It is also an object of the invention to provide an improved magnet wire which has increased resistance to insulation degradation caused by pulsed voltage surges.

5 It is also an object of the invention to provide an improved magnet wire which can withstand voltage surges approaching 3,000 volts having rise times of less than 100 kV per micro second and temperature rises to 300°C. frequencies of less than 20 kHz after the insertion of the windings in a motor rotor and stator at normal operating temperatures over the anticipated lifetime of the motor.

10 It is also an object of the invention to provide an improved magnet wire which will pass the ANSI/NEMA magnet wire standards MW1000 and in addition to ANSI/NEMA MG1-Parts 30 and 31 being developed for constant speed motors on a sinusoidal bus and general purpose induction motors used with variable frequency controls, or both, and definite purpose inverter fed motors, respectively.

15 It is also an object of the invention to provide an improved magnet wire which meets all of the performance characteristics desired by motor manufacturers for stator and rotor windings for use under corona discharge conditions.

Finally, it is an object of the invention to provide an improved magnet wire which possesses all of the above-identified features.

20 In the broader aspects of the invention, there is provided a pulsed voltage surge resistant magnet wire comprising a conductor, a continuous and concentric and flexible uniform coat of base material superimposed on the conductor. The shield has therein an effective amount of a particulate material. The shield may be superimposed on the coat of base insulation material, and may have a continuous and concentric and flexible and uniform top coat of insulation material  
25 superimposed thereon.

#### Brief Description Of The Drawings

The above-mentioned and other features and objects of the invention and the manner of attaining them will become more apparent and the invention itself will  
30 be better understood by reference to the following description of an embodiment of the invention taken in conjunction with the accompanying drawings wherein:

Figure 1 is a cross-sectional view of a magnet wire showing an electrical conductor having the improved pulsed voltage surge resistant insulation thereon.

35 Figure 2 is a cross-sectional view of a magnet wire showing an electrical conductor having the improved pulsed voltage surge resistant insulation thereon

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superimposed upon a base insulation material and having a continuous and concentric flexible and uniform top coat of insulation material superimposed on the improved pulsed voltage surge resistant insulation of the invention.

5

#### Description Of A Specific Embodiment

The improved magnet wire 10 of the invention includes a conductor 12, a continuous and concentric and flexible and uniform coat of base insulation material 14. Coat 14 may be an essentially continuous, concentric and uniform pulse voltage surge shield 16 or may have such a shield superimposed on the base insulation material 14. At least one continuous and concentric and flexible and uniform top coat 18 of insulation material may be superimposed on the shield 16 or base insulation material 14.

Fig. 2 shows a modified pulsed voltage surge resistant magnet wire 18. This magnet wire has a conductor 12, a continuous and concentric and flexible and uniform coat of base insulation material 14 superimposed on the conductor 12, an essentially continuous, concentric and uniform pulsed voltage surge shield 16 superimposed on the base insulation 14 and at least one continuous and concentric and flexible and uniform top coat 20 of insulation material superimposed on the shield 16.

Conductor 12 is a magnet wire conductor meeting all of the dimensional specifications of ANSI/NEMA MW1000 standards. Conductor 12 may be a copper or aluminum conductor in specific embodiments. Base insulation material 14 is applied to the conductor 12 in a conventional manner to provide a continuous and concentric and flexible and uniform coat of base insulation superimposed on the conductor 12.

Insulation material 14 can be of a variety of materials. These materials include polyester, polyamide, polyimide, polyurethane, polyetherimide, polyesteramideimide, epoxy, acrylic, polyamideimide, polyesterimide, NYLON, polyvinyl acetal or FORMVAR and polyarylsulfone materials. Base insulation material 14 may also include multiple coated insulation systems such as that disclosed in U.S. Patent No. 3,022,200 issued to Koerner et al in which a magnet wire conductor is insulated by an inner coat of polyester resin and an outer coat of an amideimide resin. All heretofore known base insulation materials are encompassed by the invention as the pulse voltage surge shield 16 may be superimposed also upon any conventional or heretofore disclosed, but not

commercial, base insulation material and increased resistance to pulsed voltage surge failure would be expected.

5 A primary property of the improved pulsed voltage surge resistant magnet wire of the invention is that, in all embodiments, the base insulation 14 of the magnet wire is maintained inviolate and merely shielded by shield 16 from  
10 degradation due to pulsed volt surges such as above-identified and experienced with variable frequency, PWM and/or inverter drives of AC motors. Thus, the magnet wires of this invention having, for example, polyester base insulations, should perform in all applications as well as the prior art magnet wires comprising  
15 a conductor 12 and a polyester base insulation material 14. In addition, the magnet wire of the invention has an extended life in comparison to prior art magnet wire when exposed to pulsed voltage surge resistance in use. Thus, the base insulation of the invention is designed to remain intact throughout the life of the winding, and that the base insulation will perform as designed to appropriately  
space apart adjacent conductors 12 and to provide the designed in dielectric insulative properties of the base insulation material.

The pulsed voltage surge shield 16 of the magnet wire 10 of the invention comprises a coat of resinous material in which from about 1% to about 65% weight of said shield is a particulate filler having a particle size from about 0.005 microns  
20 to about 1 micron. Various particulate fillers can be used in the pulsed voltage surge shield of the invention. These include metal oxides, such as titanium dioxide, alumina, silica, zirconium oxide, zinc oxide, iron oxide, various naturally occurring clays and combinations thereof. In specific embodiments, the iron oxides may be BAYFERROX 110 or 105M, the clays may be POLYFIL 90 hydrous clay, WC-  
25 426 and TRANSLINK77 anhydrous clay, ASP ULTRAFINE hydrous clay and/or ECC-TEX hydrous clay.

Each of the fillers have a preferred particle range from about .01 microns to about .1 microns. Each of the fillers also have a preferred surface area measured in square meters per gram of from about 9 to about 250.

30 The pulsed voltage surge shield 16 of the invention may be superimposed as an essentially continuous and concentric and uniform pulsed volt surge shield overlaying any known base insulation 14 by conventional means such as traditional solvent application, traditional extrusion applications as taught in U.S. Patent No. 4,393,809, or electrostatic deposition as taught in U.S. Patent No.  
35 5,279,863. In specific embodiments, the pulsed voltage surge shield of the

invention includes from about 5% to about 35% weight powdered filler material of the total applied resin and filler material and from about 5% to about 65% of the filled resinous magnet wire insulation material of the shield 16. The resin binder of the pulsed-voltage surge shield 16 may be any conventional magnet wire insulation material such as those above listed with regard to the base insulation material. Additionally, other resinous materials may be used for the pulsed voltage surge shield binder as no insulative properties are relied upon from the pulsed voltage surge shield 16.

The top coat 20 superimposed over the shield 16 of magnet wire 10 may be provided to provide proper mechanical protection for the shield 16 or desired surface properties of the magnet wire. In other magnet wire embodiments 10 of the invention, the resinous binder of the shield 16 provides this protection. In still other embodiments of the magnet wire 10 of the invention, the top coat 20 provides magnet wire surface properties such as lubricity, toughness and scrape resistance and the like allowing the magnet wire to be tailored for specific end uses.

The following examples are presented herein to more fully illustrate the present invention. While specific magnet wire insulation materials and particulate filler materials are described in these examples, it should be understood that each of the above generally identified magnet wire insulation materials and particulate filler materials may be substituted for those disclosed in the examples and/or combinations thereof within reasonable scientific certainty to produce a magnet wire of the invention. Thus, a variety of magnet wires of the invention are possible, all being well within the understanding of persons skilled in the art of magnet wire design, construction and manufacture:

#### Example I

A conventional polyester magnet wire enamel comprising 38.2% weight resin in commercially available cresol, phenol and aromatic hydrocarbon solvent as applied to a bare 18 AWG copper magnet wire conductor having no insulation thereon employing dyes in a conventional magnet wire coating tower at 34 meters per minute having temperatures of 450°F., 500°F. and 550°F., respectively, six passes were applied in this manner resulting in an insulation build of approximately 1.8 mils.

50 grams of fumed titanium dioxide ( $\text{TiO}_2$ ) particulate filler having an average particle size of 0.021 microns and a surface area of 35 square meters per gram was

added to 1,200 grams of a conventional polyester magnet wire enamel comprising 38.2% weight resin in a commercially available cresol, phenol and aromatic hydrocarbon solvent were intimately mixed by stirring at high speed to disperse the particulate filler throughout the enamel. The resultant enamel was then applied to the previously insulated magnet wire conductor having a continuous, concentric and flexible uniform coat of base insulation material thereon by employing dyes and a conventional magnet wire coating tower at 34 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively, 2 passes were applied in this manner to place on the previously insulated conductor the pulsed voltage surge shield of the invention resulting in an insulation build of approximately 0.4 mils.

A conventional amideimide magnet wire enamel comprising 28% weight resin in a N-methyl pyrrolidone and aromatic hydrocarbon solvent was then applied over the previously insulated conductor having both a continuous, concentric, flexible and uniform coat of base insulation material thereon. The pulsed voltage surge shield of the invention superimposed thereon by employing dyes and a conventional magnet wire coating tower at 36 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively. Two passes were applied in this manner resulting in an insulation build of approximately 0.6 to 0.8 mils.

The properties of the resultant magnet wire are shown in Table I.

#### Example II

A conventional polyester magnet wire enamel comprising 38.2% weight resin in commercially available cresol, phenol and aromatic hydrocarbon solvent as applied to a bare 18 AWG copper magnet wire conductor having no insulation thereon employing dyes in a conventional magnet wire coating tower at 34 meters per minute having temperatures of 450°F., 500°F. and 550°F., respectively, six passes were applied in this manner resulting in an insulation build of approximately 1.8 mils.

150 grams of fumed titanium dioxide ( $\text{TiO}_2$ ) particulate filler having an average particle size of 0.021 microns and a surface area of 35 square meters per gram was added to 1,200 grams of a conventional polyester magnet wire enamel comprising 38.2% weight resin in a commercially available cresol, phenol and aromatic hydrocarbon solvent were intimately mixed by stirring at high speed to disperse the particulate filler throughout the enamel. The resultant enamel was

then applied to the previously insulated magnet wire conductor having a continuous, concentric and flexible uniform coat of base insulation material thereon by employing dyes and a conventional magnet wire coating tower at 34 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively, 2 passes were applied in this manner to place on the previously insulated conductor the pulsed voltage surge shield of the invention resulting in an insulation build of approximately 0.4 mils.

A conventional NYLON magnet wire enamel comprising 20% resin weight in a phenol, cresol and aromatic hydrocarbon solvent was then applied over the previously insulated conductor having both a continuous, concentric, flexible and uniform coat of base insulation material thereon and the pulsed voltage surge shield of the invention superimposed thereon by employing dyes and a conventional magnet wire coating tower at 22 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively. Two passes were applied in this manner resulting in an insulation build of approximately 0.6 to 0.8 mils.

The properties of the resultant magnet wire are shown in Table I.

### Example III

A conventional polyester magnet wire enamel comprising 38.2% weight resin in commercially available cresol, phenol and aromatic hydrocarbon solvent as applied to a bare 18 AWG copper magnet wire conductor having no insulation thereon employing dyes in a conventional magnet wire coating tower at 34 meters per minute having temperatures of 450°F., 500°F. and 550°F., respectively, six passes were applied in this manner resulting in an insulation build of approximately 1.8 mils.

300 grams of fumed titanium dioxide ( $\text{TiO}_2$ ) particulate filler having an average particle size of 0.021 microns and a surface area of 35 square meters per gram was added to 1,200 grams of a conventional polyester magnet wire enamel comprising 38.2% weight resin in a commercially available cresol, phenol and aromatic hydrocarbon solvent were intimately mixed by stirring at high speed to disperse the particulate filler throughout the enamel. The resultant enamel was then applied to the previously insulated magnet wire conductor having a continuous, concentric and flexible uniform coat of base insulation material thereon by employing dyes and a conventional magnet wire coating tower at 34 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively,

2 passes were applied in this manner to place on the previously insulated conductor the pulsed voltage surge shield of the invention resulting in an insulation build of approximately 0.4 mils.

5 A conventional amide imide magnet wire enamel comprising 28% weight resin in a N-methyl pyrrolidone and aromatic hydrocarbon solvent was then applied over the previously insulated conductor having both a continuous, concentric, flexible and uniform coat of base insulation material thereon. The pulsed voltage surge shield of the invention superimposed thereon by employing dyes and a conventional magnet wire coating tower at 36 meters per minute, having  
10 temperatures of 450°F., 500°F. and 550°F., respectively. Two passes were applied in this manner resulting in an insulation build of approximately 0.6 to 0.8 mils.

The properties of the resultant magnet wire are shown in Table I.

#### Example IV

15 A conventional polyester magnet wire enamel comprising 38.2% weight resin in commercially available cresol, phenol and aromatic hydrocarbon solvent as applied to a bare 18 AWG copper magnet wire conductor having no insulation thereon employing dyes in a conventional magnet wire coating tower at 34 meters per minute having temperatures of 450°F., 500°F. and 550°F., respectively, six  
20 passes were applied in this manner resulting in an insulation build of approximately 1.8 mils.

50 grams of fumed alumina ( $Al_2O_3$ ) particulate filler having an average particle size of 0.013 microns and a surface area of 85 square meters per gram was added to 1,200 grams of a conventional polyester magnet wire enamel comprising  
25 38.2% weight resin in a commercially available cresol, phenol and aromatic hydrocarbon solvent were intimately mixed by stirring at high speed to disperse the particulate filler throughout the enamel. The resultant enamel was then applied to the previously insulated magnet wire conductor having a continuous, concentric and flexible uniform coat of base insulation material thereon by employing dyes  
30 and a conventional magnet wire coating tower at 34 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively, 2 passes were applied in this manner to place on the previously insulated conductor the pulsed voltage surge shield of the invention resulting in an insulation build of approximately 0.4 mils.



A conventional NYLON magnet wire enamel comprising 20% resin weight in a phenol, cresol and aromatic hydrocarbon solvent was then applied over the previously insulated conductor having both a continuous, concentric, flexible and uniform coat of base insulation material thereon and the pulsed voltage surge shield of the invention superimposed thereon by employing dyes and a conventional magnet wire coating tower at 22 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively. Two passes were applied in this manner resulting in an insulation build of approximately 0.6 to 0.8 mils.

The properties of the resultant magnet wire are shown in Table I.

#### Example V

A conventional polyester magnet wire enamel comprising 38.2% weight resin in commercially available cresol, phenol and aromatic hydrocarbon solvent as applied to a bare 18 AWG copper magnet wire conductor having no insulation thereon employing dyes in a conventional magnet wire coating tower at 34 meters per minute having temperatures of 450°F., 500°F. and 550°F., respectively, six passes were applied in this manner resulting in an insulation build of approximately 1.8 mils.

150 grams of fumed alumina ( $Al_2O_3$ ) particulate filler having an average particle size of 0.013 microns and a surface area of 85 square meters per gram was added to 1,200 grams of a conventional polyester magnet wire enamel comprising 38.2% weight resin in a commercially available cresol, phenol and aromatic hydrocarbon solvent were intimately mixed by stirring at high speed to disperse the particulate filler throughout the enamel. The resultant enamel was then applied to the previously insulated magnet wire conductor having a continuous, concentric and flexible uniform coat of base insulation material thereon by employing dyes and a conventional magnet wire coating tower at 34 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively, 2 passes were applied in this manner to place on the previously insulated conductor the pulsed voltage surge shield of the invention resulting in an insulation build of approximately 0.4 mils.

A conventional amide imide magnet wire enamel comprising 28% weight resin in a N-methyl pyrrolidone and aromatic hydrocarbon solvent was than applied over the previously insulated conductor having both a continuous, concentric, flexible and uniform coat of base insulation material thereon. The pulsed voltage

surge shield of the invention superimposed thereon by employing dyes and a conventional magnet wire coating tower at 36 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively. Two passes were applied in this manner resulting in an insulation build of approximately 0.6 to 0.8 mils.

5       The properties of the resultant magnet wire are shown in Table I.

#### Example VI

10       A conventional polyester magnet wire enamel comprising 38.2% weight resin in commercially available cresol, phenol and aromatic hydrocarbon solvent as applied to a bare 18 AWG copper magnet wire conductor having no insulation thereon employing dyes in a conventional magnet wire coating tower at 34 meters per minute having temperatures of 450°F., 500°F. and 550°F., respectively, six passes were applied in this manner resulting in an insulation build of approximately 1.8 mils.

15       300 grams of fumed alumina ( $Al_2O_3$ ) particulate filler having an average particle size of 0.013 microns and a surface area of 85 square meters per gram was added to 1,200 grams of a conventional polyester magnet wire enamel comprising 38.2% weight resin in a commercially available cresol, phenol and aromatic hydrocarbon solvent were intimately mixed by stirring at high speed to disperse the  
20       particulate filler throughout the enamel. The resultant enamel was then applied to the previously insulated magnet wire conductor having a continuous, concentric and flexible uniform coat of base insulation material thereon by employing dyes and a conventional magnet wire coating tower at 34 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively, 2 passes were applied in  
25       this manner to place on the previously insulated conductor the pulsed voltage surge shield of the invention resulting in an insulation build of approximately 0.4 mils.

30       A conventional NYLON magnet wire enamel comprising 20% resin weight in a phenol, cresol and aromatic hydrocarbon solvent was then applied over the previously insulated conductor having both a continuous, concentric, flexible and uniform coat of base insulation material thereon and the pulsed voltage surge shield of the invention superimposed thereon by employing dyes and a conventional magnet wire coating tower at 22 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively. Two passes were applied  
35       in this manner resulting in an insulation build of approximately 0.6 to 0.8 mils.

The properties of the resultant magnet wire are shown in Table I.

#### Example VII

5 A conventional polyester magnet wire enamel comprising 38.2% weight resin in commercially available cresol, phenol and aromatic hydrocarbon solvent as applied to a bare 18 AWG copper magnet wire conductor having no insulation thereon employing dyes in a conventional magnet wire coating tower at 34 meters per minute having temperatures of 450°F., 500°F. and 550°F., respectively, six passes were applied in this manner resulting in an insulation build of  
10 approximately 1.8 mils.

16 grams of fumed silica ( $\text{SiO}_2$ ) particulate filler having an average particle size of 0.016 microns and a surface area of about 90 to about 130 square meters per gram was added to 1,600 grams of a conventional polyester magnet wire enamel comprising 38.2% weight resin in a commercially available cresol, phenol and  
15 aromatic hydrocarbon solvent were intimately mixed by stirring at high speed to disperse the particulate filler throughout the enamel. The resultant enamel was then applied to the previously insulated magnet wire conductor having a continuous, concentric and flexible uniform coat of base insulation material thereon by employing dyes and a conventional magnet wire coating tower at 34  
20 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively, 2 passes were applied in this manner to place on the previously insulated conductor the pulsed voltage surge shield of the invention resulting in an insulation build of approximately 0.4 mils.

A conventional amide imide magnet wire enamel comprising 28% weight  
25 resin in a N-methyl pyrrolidone and aromatic hydrocarbon solvent was than applied over the previously insulated conductor having both a continuous, concentric, flexible and uniform coat of base insulation material thereon. The pulsed voltage surge shield of the invention superimposed thereon by employing dyes and a conventional magnet wire coating tower at 36 meters per minute, having  
30 temperatures of 450°F., 500°F. and 550°F., respectively. Two passes were applied in this manner resulting in an insulation build of approximately 0.6 to 0.8 mils.

The properties of the resultant magnet wire are shown in Table I.

#### Example VIII

A conventional polyester magnet wire enamel comprising 38.2% weight resin in commercially available cresol, phenol and aromatic hydrocarbon solvent as applied to a bare 18 AWG copper magnet wire conductor having no insulation thereon employing dyes in a conventional magnet wire coating tower at 34 meters per minute having temperatures of 450°F., 500°F. and 550°F., respectively, six passes were applied in this manner resulting in an insulation build of approximately 1.8 mils.

80 grams of fumed silica ( $\text{SiO}_2$ ) particulate filler having an average particle size of 0.016 microns and a surface area of about 90 to about 130 square meters per gram was added to 1,600 grams of a conventional polyester magnet wire enamel comprising 38.2% weight resin in a commercially available cresol, phenol and aromatic hydrocarbon solvent were intimately mixed by stirring at high speed to disperse the particulate filler throughout the enamel. The resultant enamel was then applied to the previously insulated magnet wire conductor having a continuous, concentric and flexible uniform coat of base insulation material thereon by employing dyes and a conventional magnet wire coating tower at 34 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively, 2 passes were applied in this manner to place on the previously insulated conductor the pulsed voltage surge shield of the invention resulting in an insulation build of approximately 0.4 mils.

A conventional NYLON magnet wire enamel comprising 20% resin weight in a phenol, cresol and aromatic hydrocarbon solvent was then applied over the previously insulated conductor having both a continuous, concentric, flexible and uniform coat of base insulation material thereon and the pulsed voltage surge shield of the invention superimposed thereon by employing dyes and a conventional magnet wire coating tower at 22 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively. Two passes were applied in this manner resulting in an insulation build of approximately 0.6 to 0.8 mils.

The properties of the resultant magnet wire are shown in Table I.

#### Example IX

A conventional polyester magnet wire enamel comprising 38.2% weight resin in commercially available cresol, phenol and aromatic hydrocarbon solvent as applied to a bare 18 AWG copper magnet wire conductor having no insulation thereon employing dyes in a conventional magnet wire coating tower at 34 meters

per minute having temperatures of 450°F., 500°F. and 550°F., respectively, six passes were applied in this manner resulting in an insulation build of approximately 1.8 mils.

5 160-grams of fumed silica ( $\text{SiO}_2$ ) particulate filler having an average particle size of 0.016 microns and a surface area of about 90 to about 130 square meters per gram was added to 1,600 grams of a conventional polyester magnet wire enamel comprising 38.2% weight resin in a commercially available cresol, phenol and aromatic hydrocarbon solvent were intimately mixed by stirring at high speed to disperse the particulate filler throughout the enamel. The resultant enamel was  
10 then applied to the previously insulated magnet wire conductor having a continuous, concentric and flexible uniform coat of base insulation material thereon by employing dyes and a conventional magnet wire coating tower at 34 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively, 2 passes were applied in this manner to place on the previously insulated  
15 conductor the pulsed voltage surge shield of the invention resulting in an insulation build of approximately 0.4 mils.

A conventional amide imide magnet wire enamel comprising 28% weight resin in a N-methyl pyrrolidone and aromatic hydrocarbon solvent was then applied over the previously insulated conductor having both a continuous, concentric,  
20 flexible and uniform coat of base insulation material thereon. The pulsed voltage surge shield of the invention superimposed thereon by employing dyes and a conventional magnet wire coating tower at 36 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively. Two passes were applied in this manner resulting in an insulation build of approximately 0.6 to 0.8 mils.

25 The properties of the resultant magnet wire are shown in Table I.

#### Example X

A conventional polyester magnet wire enamel comprising 38.2% weight resin in commercially available cresol, phenol and aromatic hydrocarbon solvent as  
30 applied to a bare 18 AWG copper magnet wire conductor having no insulation thereon employing dyes in a conventional magnet wire coating tower at 34 meters per minute having temperatures of 450°F., 500°F. and 550°F., respectively, eight passes were applied in this manner resulting in an insulation build of approximately 2.3 mils.

A conventional NYLON magnet wire enamel comprising 20% resin weight in a phenol, cresol and aromatic hydrocarbon solvent was then applied over the previously insulated conductor having both a continuous, concentric, flexible and uniform coat of base insulation material thereon and the pulsed voltage surge shield of the invention superimposed thereon by employing dyes and a conventional magnet wire coating tower at 22 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively. Two passes were applied in this manner resulting in an insulation build of approximately 0.6 to 0.8 mils.

The properties of the resultant magnet wire are shown in Table I.

#### Example XI

A conventional polyester magnet wire enamel comprising 38.2% weight resin in commercially available cresol, phenol and aromatic hydrocarbon solvent as applied to a bare 18 AWG copper magnet wire conductor having no insulation thereon employing dyes in a conventional magnet wire coating tower at 34 meters per minute having temperatures of 450°F., 500°F. and 550°F., respectively, eight passes were applied in this manner resulting in an insulation build of approximately 2.3 mils.

A conventional amide imide magnet wire enamel comprising 28% weight resin in a N-methyl pyrrolidone and aromatic hydrocarbon solvent was then applied over the previously insulated conductor having both a continuous, concentric, flexible and uniform coat of base insulation material thereon. The pulsed voltage surge shield of the invention superimposed thereon by employing dyes and a conventional magnet wire coating tower at 36 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively. Two passes were applied in this manner resulting in an insulation build of approximately 0.6 to 0.8 mils.

The properties of the resultant magnet wire are shown in Table I.

#### Example XII

A conventional polyester magnet wire enamel comprising 38.2% weight resin in commercially available cresol, phenol and aromatic hydrocarbon solvent as applied to a bare 18 AWG copper magnet wire conductor having no insulation thereon employing dyes in a conventional magnet wire coating tower at 34 meters per minute having temperatures of 450°F., 500°F. and 550°F., respectively, six

passes were applied in this manner resulting in an insulation build of approximately 1.9 mils.

150 grams of zinc oxide (ZnO) particulate filler having an average particle size of 0.12 microns and a surface area of 90 square meters per gram was added to 2,584 grams of a conventional polyester magnet wire enamel comprising 38.2% weight resin in a commercially available cresol, phenol and aromatic hydrocarbon solvent were intimately mixed in a conventional ball mill to disperse the particulate filler throughout the enamel. The resultant enamel was then applied to the previously insulated magnet wire conductor having a continuous, concentric and flexible uniform coat of base insulation material thereon by employing dyes and a conventional magnet wire coating tower at 34 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively, 2 passes were applied in this manner to place on the previously insulated conductor the pulsed voltage surge shield of the invention resulting in an insulation build of approximately 0.4 mils.

A conventional NYLON magnet wire enamel comprising 20% resin weight in a phenol, cresol and aromatic hydrocarbon solvent was then applied over the previously insulated conductor having both a continuous, concentric, flexible and uniform coat of base insulation material thereon and the pulsed voltage surge shield of the invention superimposed thereon by employing dyes and a conventional magnet wire coating tower at 22 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively. Two passes were applied in this manner resulting in an insulation build of approximately 0.6 to 0.8 mils.

The properties of the resultant magnet wire are shown in Table I.

#### Example XIII

A conventional polyester magnet wire enamel comprising 38.2% weight resin in commercially available cresol, phenol and aromatic hydrocarbon solvent as applied to a bare 18 AWG copper magnet wire conductor having no insulation thereon employing dyes in a conventional magnet wire coating tower at 34 meters per minute having temperatures of 450°F., 500°F. and 550°F., respectively, six passes were applied in this manner resulting in an insulation build of approximately 1.9 mils.

450 grams of zinc oxide (ZnO) particulate filler having an average particle size of 0.12 microns and a surface area of 90 square meters per gram was added to

2,584 grams of a conventional polyester magnet wire enamel comprising 38.2% weight resin in a commercially available cresol, phenol and aromatic hydrocarbon solvent were intimately mixed by a conventional ball mill to disperse the particulate filler throughout the enamel. The resultant enamel was then applied to the  
5 previously insulated magnet wire conductor having a continuous, concentric and flexible uniform coat of base insulation material thereon by employing dyes and a conventional magnet wire coating tower at 34 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively, 2 passes were applied in this manner to place on the previously insulated conductor the pulsed voltage  
10 surge shield of the invention resulting in an insulation build of approximately 0.4 mils.

A conventional amide imide magnet wire enamel comprising 28% weight resin in a N-methyl pyrrolidone and aromatic hydrocarbon solvent was then applied over the previously insulated conductor having both a continuous, concentric,  
15 flexible and uniform coat of base insulation material thereon. The pulsed voltage surge shield of the invention superimposed thereon by employing dyes and a conventional magnet wire coating tower at 36 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively. Two passes were applied in this manner resulting in an insulation build of approximately 0.6 to 0.8 mils.  
20

The properties of the resultant magnet wire are shown in Table I.

#### Example XIV

A conventional polyester magnet wire enamel comprising 38.2% weight resin in commercially available cresol, phenol and aromatic hydrocarbon solvent as  
25 applied to a bare 18 AWG copper magnet wire conductor having no insulation thereon employing dyes in a conventional magnet wire coating tower at 34 meters per minute having temperatures of 450°F., 500°F. and 550°F., respectively, six passes were applied in this manner resulting in an insulation build of approximately 1.9 mils.

30 900 grams of zinc oxide (ZnO) particulate filler having an average particle size of 0.12 microns and a surface area of 90 square meters per gram was added to 2,584 grams of a conventional polyester magnet wire enamel comprising 38.2% weight resin in a commercially available cresol, phenol and aromatic hydrocarbon solvent were intimately mixed by a conventional ball mill to disperse the particulate  
35 filler throughout the enamel. The resultant enamel was then applied to the



previously insulated magnet wire conductor having a continuous, concentric and flexible uniform coat of base insulation material thereon by employing dyes and a conventional magnet wire coating tower at 34 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively, 2 passes were applied in this manner to place on the previously insulated conductor the pulsed voltage surge shield of the invention resulting in an insulation build of approximately 0.4 mils.

A conventional NYLON magnet wire enamel comprising 20% resin weight in a phenol, cresol and aromatic hydrocarbon solvent was then applied over the previously insulated conductor having both a continuous, concentric, flexible and uniform coat of base insulation material thereon and the pulsed voltage surge shield of the invention superimposed thereon by employing dyes and a conventional magnet wire coating tower at 22 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively. Two passes were applied in this manner resulting in an insulation build of approximately 0.6 to 0.8 mils.

The properties of the resultant magnet wire are shown in Table I.

#### Example XV

A conventional polyester magnet wire enamel comprising 38.2% weight resin in commercially available cresol, phenol and aromatic hydrocarbon solvent as applied to a bare 18 AWG copper magnet wire conductor having no insulation thereon employing dyes in a conventional magnet wire coating tower at 34 meters per minute having temperatures of 450°F., 500°F. and 550°F., respectively, six passes were applied in this manner resulting in an insulation build of approximately 1.9 mils.

600 grams of zinc oxide (ZnO) particulate filler having an average particle size of 0.12 microns and a surface area of 90 square meters per gram was added to 2,584 grams of a conventional polyester magnet wire enamel comprising 38.2% weight resin in a commercially available cresol, phenol and aromatic hydrocarbon solvent were intimately mixed by a conventional ball mill to disperse the particulate filler throughout the enamel. The resultant enamel was then applied to the previously insulated magnet wire conductor having a continuous, concentric and flexible uniform coat of base insulation material thereon by employing dyes and a conventional magnet wire coating tower at 34 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively, 2 passes were applied in

this manner to place on the previously insulated conductor the pulsed voltage surge shield of the invention resulting in an insulation build of approximately 0.4 mils.

5 A conventional amide imide magnet wire enamel comprising 28% weight resin in a N-methyl pyrrolidone and aromatic hydrocarbon solvent was than applied over the previously insulated conductor having both a continuous, concentric, flexible and uniform coat of base insulation material thereon. The pulsed voltage surge shield of the invention superimposed thereon by employing dyes and a conventional magnet wire coating tower at 36 meters per minute, having  
10 temperatures of 450°F., 500°F. and 550°F., respectively. Two passes were applied in this manner resulting in an insulation build of approximately 0.6 to 0.8 mils.

The properties of the resultant magnet wire are shown in Table I.

#### Example XVI

15 A conventional polyester magnet wire enamel comprising 38.2% weight resin in commercially available cresol, phenol and aromatic hydrocarbon solvent as applied to a bare 18 AWG copper magnet wire conductor having no insulation thereon employing dyes in a conventional magnet wire coating tower at 34 meters per minute having temperatures of 450°F., 500°F. and 550°F., respectively, six  
20 passes were applied in this manner resulting in an insulation build of approximately 1.8 mils.

100 grams of equal parts of fumed titanium dioxide, fumed alumina and zinc oxide particulate filler having an average particle size of 0.016 microns and an average surface area of 92 square meters per gram was added to 2,580 grams of a  
25 conventional polyester magnet wire enamel comprising 38.2% weight resin in a commercially available cresol, phenol and aromatic hydrocarbon solvent were intimately mixed by stirring at high speed to disperse the particulate filler throughout the enamel. The resultant enamel was then applied to the previously insulated magnet wire conductor having a continuous, concentric and flexible  
30 uniform coat of base insulation material thereon by employing dyes and a conventional magnet wire coating tower at 34 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively, 2 passes were applied in this manner to place on the previously insulated conductor the pulsed voltage surge shield of the invention resulting in an insulation build of approximately 0.4 mils.

A conventional NYLON magnet wire enamel comprising 20% resin weight in a phenol, cresol and aromatic hydrocarbon solvent was then applied over the previously insulated conductor having both a continuous, concentric, flexible and uniform coat of base insulation material thereon and the pulsed voltage surge shield of the invention superimposed thereon by employing dyes and a conventional magnet wire coating tower at 22 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively. Two passes were applied in this manner resulting in an insulation build of approximately 0.6 to 0.8 mils.

The properties of the resultant magnet wire are shown in Table I.

#### Example XVII

A conventional polyester magnet wire enamel comprising 38.2% weight resin in commercially available cresol, phenol and aromatic hydrocarbon solvent as applied to a bare 18 AWG copper magnet wire conductor having no insulation thereon employing dyes in a conventional magnet wire coating tower at 34 meters per minute having temperatures of 450°F., 500°F. and 550°F., respectively, six passes were applied in this manner resulting in an insulation build of approximately 1.8 mils.

300 grams of equal parts of fumed titanium dioxide, fumed alumina and zinc oxide particulate filler having an average particle size of 0.016 microns and an average surface area of 92 square meters per gram was added to 2,580 grams of a conventional polyester magnet wire enamel comprising 38.2% weight resin in a commercially available cresol, phenol and aromatic hydrocarbon solvent were intimately mixed by stirring at high speed to disperse the particulate filler throughout the enamel. The resultant enamel was then applied to the previously insulated magnet wire conductor having a continuous, concentric and flexible uniform coat of base insulation material thereon by employing dyes and a conventional magnet wire coating tower at 34 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively, 2 passes were applied in this manner to place on the previously insulated conductor the pulsed voltage surge shield of the invention resulting in an insulation build of approximately 0.4 mils.

A conventional amide imide magnet wire enamel comprising 28% weight resin in a N-methyl pyrrolidone and aromatic hydrocarbon solvent was then applied over the previously insulated conductor having both a continuous, concentric, flexible and uniform coat of base insulation material thereon. The pulsed voltage

surge shield of the invention superimposed thereon by employing dyes and a conventional magnet wire coating tower at 36 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively. Two passes were applied in this manner resulting in an insulation build of approximately 0.6 to 0.8 mils.

5 The properties of the resultant magnet wire are shown in Table I.

#### Example XVIII

10 A conventional polyester magnet wire enamel comprising 38.2% weight resin in commercially available cresol, phenol and aromatic hydrocarbon solvent as applied to a bare 18 AWG copper magnet wire conductor having no insulation thereon employing dyes in a conventional magnet wire coating tower at 34 meters per minute having temperatures of 450°F., 500°F. and 550°F., respectively, six passes were applied in this manner resulting in an insulation build of approximately 1.8 mils.

15 400 grams of equal parts of fumed titanium dioxide, fumed alumina and zinc oxide particulate filler having an average particle size of 0.016 microns and an average surface area of 92 square meters per gram was added to 2,580 grams of a conventional polyester magnet wire enamel comprising 38.2% weight resin in a commercially available cresol, phenol and aromatic hydrocarbon solvent were  
20 intimately mixed by stirring at high speed to disperse the particulate filler throughout the enamel. The resultant enamel was then applied to the previously insulated magnet wire conductor having a continuous, concentric and flexible uniform coat of base insulation material thereon by employing dyes and a conventional magnet wire coating tower at 34 meters per minute, having temperatures of  
25 450°F., 500°F. and 550°F., respectively, 2 passes were applied in this manner to place on the previously insulated conductor the pulsed voltage surge shield of the invention resulting in an insulation build of approximately 0.4 mils.

30 A conventional NYLON magnet wire enamel comprising 20% resin weight in a phenol, cresol and aromatic hydrocarbon solvent was then applied over the previously insulated conductor having both a continuous, concentric, flexible and uniform coat of base insulation material thereon and the pulsed voltage surge shield of the invention superimposed thereon by employing dyes and a conventional magnet wire coating tower at 22 meters per minute, having  
35 temperatures of 450°F., 500°F. and 550°F., respectively. Two passes were applied in this manner resulting in an insulation build of approximately 0.6 to 0.8 mils.

The properties of the resultant magnet wire are shown in Table I.

#### Example XIX

5 A conventional polyester magnet wire enamel comprising 38.2% weight resin in commercially available cresol, phenol and aromatic hydrocarbon solvent as applied to a bare 18 AWG copper magnet wire conductor having no insulation thereon employing dyes in a conventional magnet wire coating tower at 34 meters per minute having temperatures of 450°F., 500°F. and 550°F., respectively, six passes were applied in this manner resulting in an insulation build of  
10 approximately 1.8 mils.

75 grams of WC-426 clay particulate filler having an average particle size of 0.7 microns and a surface area of 13 to about 17 square meters per gram was added to 1,500 grams of a conventional polyester magnet wire enamel comprising 38.2% weight resin in a commercially available cresol, phenol and aromatic  
15 hydrocarbon solvent were intimately mixed by a conventional ball mill to disperse the particulate filler throughout the enamel. The resultant enamel was then applied to the previously insulated magnet wire conductor having a continuous, concentric and flexible uniform coat of base insulation material thereon by employing dyes and a conventional magnet wire coating tower at 34 meters per  
20 minute, having temperatures of 450°F., 500°F. and 550°F., respectively, 2 passes were applied in this manner to place on the previously insulated conductor the pulsed voltage surge shield of the invention resulting in an insulation build of approximately 0.4 mils.

A conventional amide imide magnet wire enamel comprising 28% weight  
25 resin in a N-methyl pyrrolidone and aromatic hydrocarbon solvent was then applied over the previously insulated conductor having both a continuous, concentric, flexible and uniform coat of base insulation material thereon. The pulsed voltage surge shield of the invention superimposed thereon by employing dyes and a conventional magnet wire coating tower at 36 meters per minute, having  
30 temperatures of 450°F., 500°F. and 550°F., respectively. Two passes were applied in this manner resulting in an insulation build of approximately 0.6 to 0.8 mils.

The properties of the resultant magnet wire are shown in Table I.

#### Example XX

A conventional polyester magnet wire enamel comprising 38.2% weight resin in commercially available cresol, phenol and aromatic hydrocarbon solvent as applied to a bare 18 AWG copper magnet wire conductor having no insulation thereon employing dyes in a conventional magnet wire coating tower at 34 meters per minute having temperatures of 450°F., 500°F. and 550°F., respectively, six passes were applied in this manner resulting in an insulation build of approximately 1.8 mils.

250 grams of WC-426 clay particulate filler having an average particle size of 0.7 microns and a surface area of 13 to about 17 square meters per gram was added to 1,500 grams of a conventional polyester magnet wire enamel comprising 38.2% weight resin in a commercially available cresol, phenol and aromatic hydrocarbon solvent were intimately mixed by a conventional ball mill to disperse the particulate filler throughout the enamel. The resultant enamel was then applied to the previously insulated magnet wire conductor having a continuous, concentric and flexible uniform coat of base insulation material thereon by employing dyes and a conventional magnet wire coating tower at 34 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively, 2 passes were applied in this manner to place on the previously insulated conductor the pulsed voltage surge shield of the invention resulting in an insulation build of approximately 0.4 mils.

A conventional NYLON magnet wire enamel comprising 20% resin weight in a phenol, cresol and aromatic hydrocarbon solvent was then applied over the previously insulated conductor having both a continuous, concentric, flexible and uniform coat of base insulation material thereon and the pulsed voltage surge shield of the invention superimposed thereon by employing dyes and a conventional magnet wire coating tower at 22 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively. Two passes were applied in this manner resulting in an insulation build of approximately 0.6 to 0.8 mils.

The properties of the resultant magnet wire are shown in Table I.

#### Example XXI

A polyarylsulfone magnet wire enamel comprising 21% weight resin in commercially available cresol, phenol and aromatic hydrocarbon solvent as applied to a bare 18 AWG copper magnet wire conductor having no insulation thereon employing dyes in a conventional magnet wire coating tower at 16 meters per

minute having temperatures of 450°F., 500°F. and 550°F., respectively, six passes were applied in this manner resulting in an insulation build of approximately 1.8 mils.

25 grams of fumed titanium dioxide (TiO<sub>2</sub>) particulate filler having an average  
5 particle size of 0.021 microns and a surface area of 35 square meters per gram was added to 1,200 grams of a polyarylsulfone magnet wire enamel comprising 21% weight resin in a commercially available cresol, phenol and aromatic hydrocarbon solvent were intimately mixed by stirring at high speed to disperse the particulate filler throughout the enamel. The resultant enamel was then applied to the  
10 previously insulated magnet wire conductor having a continuous, concentric and flexible uniform coat of base insulation material thereon by employing dyes and a conventional magnet wire coating tower at 16 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively, 2 passes were applied in this manner to place on the previously insulated conductor the pulsed voltage  
15 surge shield of the invention resulting in an insulation build of approximately 0.4 mils.

A conventional amide imide magnet wire enamel comprising 28% weight resin in a N-methyl pyrrolidone and aromatic hydrocarbon solvent was then applied over the previously insulated conductor having both a continuous, concentric,  
20 flexible and uniform coat of base insulation material thereon. The pulsed voltage surge shield of the invention superimposed thereon by employing dyes and a conventional magnet wire coating tower at 36 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively. Two passes were applied in this manner resulting in an insulation build of approximately 0.6 to 0.8 mils.

25 The properties of the resultant magnet wire are shown in Table I.

#### Example XXII

A polyarylsulfone magnet wire enamel comprising 21% weight resin in commercially available cresol, phenol and aromatic hydrocarbon solvent as applied  
30 to a bare 18 AWG copper magnet wire conductor having no insulation thereon employing dyes in a conventional magnet wire coating tower at 16 meters per minute having temperatures of 450°F., 500°F. and 550°F., respectively, six passes were applied in this manner resulting in an insulation build of approximately 1.8 mils.

75 grams of fumed titanium dioxide ( $\text{TiO}_2$ ) particulate filler having an average particle size of 0.021 microns and a surface area of 35 square meters per gram was added to 1,200 grams of a polyarylsulfone magnet wire enamel comprising 21% weight resin in a commercially available cresol, phenol and aromatic hydrocarbon solvent were intimately mixed by stirring at high speed to disperse the particulate filler throughout the enamel. The resultant enamel was then applied to the previously insulated magnet wire conductor having a continuous, concentric and flexible uniform coat of base insulation material thereon by employing dyes and a conventional magnet wire coating tower at 16 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively, 2 passes were applied in this manner to place on the previously insulated conductor the pulsed voltage surge shield of the invention resulting in an insulation build of approximately 0.4 mils.

A conventional NYLON magnet wire enamel comprising 20% resin weight in a phenol, cresol and aromatic hydrocarbon solvent was then applied over the previously insulated conductor having both a continuous, concentric, flexible and uniform coat of base insulation material thereon and the pulsed voltage surge shield of the invention superimposed thereon by employing dyes and a conventional magnet wire coating tower at 22 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively. Two passes were applied in this manner resulting in an insulation build of approximately 0.6 to 0.8 mils.

The properties of the resultant magnet wire are shown in Table I.

#### Example XXIII

A polyarylsulfone magnet wire enamel comprising 21% weight resin in commercially available cresol, phenol and aromatic hydrocarbon solvent as applied to a bare 18 AWG copper magnet wire conductor having no insulation thereon employing dyes in a conventional magnet wire coating tower at 16 meters per minute having temperatures of 450°F., 500°F. and 550°F., respectively, six passes were applied in this manner resulting in an insulation build of approximately 1.8 mils.

125 grams of fumed titanium dioxide ( $\text{TiO}_2$ ) particulate filler having an average particle size of 0.021 microns and a surface area of 35 square meters per gram was added to 1,200 grams of a polyarylsulfone magnet wire enamel comprising 21% weight resin in a commercially available cresol, phenol and



aromatic hydrocarbon solvent were intimately mixed by stirring at high speed to disperse the particulate filler throughout the enamel. The resultant enamel was then applied to the previously insulated magnet wire conductor having a continuous, concentric and flexible uniform coat of base insulation material thereon by employing dyes and a conventional magnet wire coating tower at 16 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively, 2 passes were applied in this manner to place on the previously insulated conductor the pulsed voltage surge shield of the invention resulting in an insulation build of approximately 0.4 mils.

A conventional amide imide magnet wire enamel comprising 28% weight resin in a N-methyl pyrrolidone and aromatic hydrocarbon solvent was then applied over the previously insulated conductor having both a continuous, concentric, flexible and uniform coat of base insulation material thereon. The pulsed voltage surge shield of the invention superimposed thereon by employing dyes and a conventional magnet wire coating tower at 36 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively. Two passes were applied in this manner resulting in an insulation build of approximately 0.6 to 0.8 mils.

The properties of the resultant magnet wire are shown in Table I.

#### Example XXIV

A polyarylsulfone magnet wire enamel comprising 21% weight resin in commercially available cresol, phenol and aromatic hydrocarbon solvent as applied to a bare 18 AWG copper magnet wire conductor having no insulation thereon employing dyes in a conventional magnet wire coating tower at 16 meters per minute having temperatures of 450°F., 500°F. and 550°F., respectively, six passes were applied in this manner resulting in an insulation build of approximately 1.8 mils.

25 grams of fumed alumina ( $Al_2O_3$ ) particulate filler having an average particle size of 0.013 microns and a surface area of 85 square meters per gram was added to 1,200 grams of a polyarylsulfone magnet wire enamel comprising 21% weight resin in a commercially available cresol, phenol and aromatic hydrocarbon solvent were intimately mixed by stirring at high speed to disperse the particulate filler throughout the enamel. The resultant enamel was then applied to the previously insulated magnet wire conductor having a continuous, concentric and

flexible uniform coat of base insulation material thereon by employing dyes and a conventional magnet wire coating tower at 16 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively, 2 passes were applied in this manner to place on the previously insulated conductor the pulsed voltage surge shield of the invention resulting in an insulation build of approximately 0.4 mils.

A conventional NYLON magnet wire enamel comprising 20% resin weight in a phenol, cresol and aromatic hydrocarbon solvent was then applied over the previously insulated conductor having both a continuous, concentric, flexible and uniform coat of base insulation material thereon and the pulsed voltage surge shield of the invention superimposed thereon by employing dyes and a conventional magnet wire coating tower at 31 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively. Two passes were applied in this manner resulting in an insulation build of approximately 0.6 to 0.8 mils.

The properties of the resultant magnet wire are shown in Table I.

#### Example XXV

A polyarylsulfone magnet wire enamel comprising 21% weight resin in commercially available cresol, phenol and aromatic hydrocarbon solvent as applied to a bare 18 AWG copper magnet wire conductor having no insulation thereon employing dyes in a conventional magnet wire coating tower at 16 meters per minute having temperatures of 450°F., 500°F. and 550°F., respectively, six passes were applied in this manner resulting in an insulation build of approximately 1.8 mils.

75 grams of fumed alumina ( $Al_2O_3$ ) particulate filler having an average particle size of 0.013 microns and a surface area of 85 square meters per gram was added to 1,200 grams of a polyarylsulfone magnet wire enamel comprising 21% weight resin in a commercially available cresol, phenol and aromatic hydrocarbon solvent were intimately mixed by stirring at high speed to disperse the particulate filler throughout the enamel. The resultant enamel was then applied to the previously insulated magnet wire conductor having a continuous, concentric and flexible uniform coat of base insulation material thereon by employing dyes and a conventional magnet wire coating tower at 16 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively, 2 passes were applied in this manner to place on the previously insulated conductor the pulsed voltage

surge shield of the invention resulting in an insulation build of approximately 0.4 mils.

A conventional amide imide magnet wire enamel comprising 28% weight resin in a N-methyl pyrrolidone and aromatic hydrocarbon solvent was then applied over the previously insulated conductor having both a continuous, concentric, flexible and uniform coat of base insulation material thereon. The pulsed voltage surge shield of the invention superimposed thereon by employing dyes and a conventional magnet wire coating tower at 36 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively. Two passes were applied in this manner resulting in an insulation build of approximately 0.6 to 0.8 mils.

The properties of the resultant magnet wire are shown in Table I.

#### Example XXVI

A polyarylsulfone magnet wire enamel comprising 21% weight resin in commercially available cresol, phenol and aromatic hydrocarbon solvent as applied to a bare 18 AWG copper magnet wire conductor having no insulation thereon employing dyes in a conventional magnet wire coating tower at 16 meters per minute having temperatures of 450°F., 500°F. and 550°F., respectively, six passes were applied in this manner resulting in an insulation build of approximately 1.8 mils.

150 grams of fumed alumina ( $Al_2O_3$ ) particulate filler having an average particle size of 0.013 microns and a surface area of 85 square meters per gram was added to 1,200 grams of a polyarylsulfone magnet wire enamel comprising 21% weight resin in a commercially available cresol, phenol and aromatic hydrocarbon solvent were intimately mixed by stirring at high speed to disperse the particulate filler throughout the enamel. The resultant enamel was then applied to the previously insulated magnet wire conductor having a continuous, concentric and flexible uniform coat of base insulation material thereon by employing dyes and a conventional magnet wire coating tower at 16 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively, 2 passes were applied in this manner to place on the previously insulated conductor the pulsed voltage surge shield of the invention resulting in an insulation build of approximately 0.4 mils.

A conventional NYLON magnet wire enamel comprising 20% resin weight in a phenol, cresol and aromatic hydrocarbon solvent was then applied over the

previously insulated conductor having both a continuous, concentric, flexible and uniform coat of base insulation material thereon and the pulsed voltage surge shield of the invention superimposed thereon by employing dyes and a conventional magnet wire coating tower at 22 meters per minute, having  
5 temperatures of 450°F., 500°F. and 550°F., respectively. Two passes were applied in this manner resulting in an insulation build of approximately 0.6 to 0.8 mils.

The properties of the resultant magnet wire are shown in Table I.

#### Example XXVII

10 A polyarylsulfone magnet wire enamel comprising 21% weight resin in commercially available cresol, phenol and aromatic hydrocarbon solvent as applied to a bare 18 AWG copper magnet wire conductor having no insulation thereon employing dyes in a conventional magnet wire coating tower at 16 meters per  
15 minute having temperatures of 450°F., 500°F. and 550°F., respectively, six passes were applied in this manner resulting in an insulation build of approximately 1.8 mils.

16 grams of fumed silica ( $\text{SiO}_2$ ) particulate filler having an average particle size of 0.016 microns and a surface area of about 90 to about 130 square meters per gram was added to 1,600 grams of a polyarylsulfone magnet wire enamel  
20 comprising 21% weight resin in a commercially available cresol, phenol and aromatic hydrocarbon solvent were intimately mixed by stirring at high speed to disperse the particulate filler throughout the enamel. The resultant enamel was then applied to the previously insulated magnet wire conductor having a  
25 continuous, concentric and flexible uniform coat of base insulation material thereon by employing dyes and a conventional magnet wire coating tower at 16 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively, 2 passes were applied in this manner to place on the previously insulated conductor the pulsed voltage surge shield of the invention resulting in an  
insulation build of approximately 0.4 mils.

30 A conventional amide imide magnet wire enamel comprising 28% weight resin in a N-methyl pyrrolidone and aromatic hydrocarbon solvent was than applied over the previously insulated conductor having both a continuous, concentric, flexible and uniform coat of base insulation material thereon. The pulsed voltage surge shield of the invention superimposed thereon by employing dyes and a  
35 conventional magnet wire coating tower at 36 meters per minute, having

temperatures of 450°F., 500°F. and 550°F., respectively. Two passes were applied in this manner resulting in an insulation build of approximately 0.6 to 0.8 mils.

The properties of the resultant magnet wire are shown in Table I.

#### 5 Example XXVIII

A polyarylsulfone magnet wire enamel comprising 21% weight resin in commercially available cresol, phenol and aromatic hydrocarbon solvent as applied to a bare 18 AWG copper magnet wire conductor having no insulation thereon employing dyes in a conventional magnet wire coating tower at 16 meters per  
10 minute having temperatures of 450°F., 500°F. and 550°F., respectively, six passes were applied in this manner resulting in an insulation build of approximately 1.8 mils.

80 grams of fumed silica ( $\text{SiO}_2$ ) particulate filler having an average particle size of 0.016 microns and a surface area of about 90 to about 130 square meters  
15 per gram was added to 1,600 grams of a polyarylsulfone magnet wire enamel comprising 21% weight resin in a commercially available cresol, phenol and aromatic hydrocarbon solvent were intimately mixed by stirring at high speed to disperse the particulate filler throughout the enamel. The resultant enamel was then applied to the previously insulated magnet wire conductor having a  
20 continuous, concentric and flexible uniform coat of base insulation material thereon by employing dyes and a conventional magnet wire coating tower at 16 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively, 2 passes were applied in this manner to place on the previously insulated conductor the pulsed voltage surge shield of the invention resulting in an  
25 insulation build of approximately 0.4 mils.

A conventional NYLON magnet wire enamel comprising 20% resin weight in a phenol, cresol and aromatic hydrocarbon solvent was then applied over the previously insulated conductor having both a continuous, concentric, flexible and uniform coat of base insulation material thereon and the pulsed voltage surge  
30 shield of the invention superimposed thereon by employing dyes and a conventional magnet wire coating tower at 22 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively. Two passes were applied in this manner resulting in an insulation build of approximately 0.6 to 0.8 mils.

The properties of the resultant magnet wire are shown in Table I.

35

## Example XXIX

A polyarylsulfone magnet wire enamel comprising 21% weight resin in commercially available cresol, phenol and aromatic hydrocarbon solvent as applied to a bare 18 AWG copper magnet wire conductor having no insulation thereon  
5 employing dyes in a conventional magnet wire coating tower at 16 meters per minute having temperatures of 450°F., 500°F. and 550°F., respectively, six passes were applied in this manner resulting in an insulation build of approximately 1.8 mils.

160 grams of fumed silica ( $\text{SiO}_2$ ) particulate filler having an average particle  
10 size of 0.016 microns and a surface area of about 90 to about 130 square meters per gram was added to 1,600 grams of a polyarylsulfone magnet wire enamel comprising 21% weight resin in a commercially available cresol, phenol and aromatic hydrocarbon solvent were intimately mixed by stirring at high speed to  
15 disperse the particulate filler throughout the enamel. The resultant enamel was then applied to the previously insulated magnet wire conductor having a continuous, concentric and flexible uniform coat of base insulation material thereon by employing dyes and a conventional magnet wire coating tower at 16 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively, 2 passes were applied in this manner to place on the previously insulated  
20 conductor the pulsed voltage surge shield of the invention resulting in an insulation build of approximately 0.4 mils.

A conventional amide imide magnet wire enamel comprising 28% weight resin in a N-methyl pyrrolidone and aromatic hydrocarbon solvent was then applied  
25 over the previously insulated conductor having both a continuous, concentric, flexible and uniform coat of base insulation material thereon. The pulsed voltage surge shield of the invention superimposed thereon by employing dyes and a conventional magnet wire coating tower at 36 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively. Two passes were applied in this manner resulting in an insulation build of approximately 0.6 to 0.8 mils.

30 The properties of the resultant magnet wire are shown in Table I.

## Example XXX

A polyarylsulfone magnet wire enamel comprising 21% weight resin in commercially available cresol, phenol and aromatic hydrocarbon solvent as applied  
35 to a bare 18 AWG copper magnet wire conductor having no insulation thereon

employing dyes in a conventional magnet wire coating tower at 16 meters per minute having temperatures of 450°F., 500°F. and 550°F., respectively, six passes were applied in this manner resulting in an insulation build of approximately 1.9 mils.

5           49 grams of zinc oxide (ZnO) particulate filler having an average particle size of 0.12 microns and a surface area of 90 square meters per gram was added to 2,584 grams of a polyarylsulfone magnet wire enamel comprising 21% weight resin in a commercially available cresol, phenol and aromatic hydrocarbon solvent were intimately mixed by a conventional ball mill to disperse the particulate filler  
10 throughout the enamel. The resultant enamel was then applied to the previously insulated magnet wire conductor having a continuous, concentric and flexible uniform coat of base insulation material thereon by employing dyes and a conventional magnet wire coating tower at 16 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively, 2 passes were applied in this manner to  
15 place on the previously insulated conductor the pulsed voltage surge shield of the invention resulting in an insulation build of approximately 0.4 mils.

A conventional NYLON magnet wire enamel comprising 20% resin weight in a phenol, cresol and aromatic hydrocarbon solvent was then applied over the previously insulated conductor having both a continuous, concentric, flexible and  
20 uniform coat of base insulation material thereon and the pulsed voltage surge shield of the invention superimposed thereon by employing dyes and a conventional magnet wire coating tower at 31 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively. Two passes were applied in this manner resulting in an insulation build of approximately 0.6 to 0.8 mils.

25           The properties of the resultant magnet wire are shown in Table I.

#### Example XXXI

A polyarylsulfone magnet wire enamel comprising 21% weight resin in commercially available cresol, phenol and aromatic hydrocarbon solvent as applied  
30 to a bare 18 AWG copper magnet wire conductor having no insulation thereon employing dyes in a conventional magnet wire coating tower at 16 meters per minute having temperatures of 450°F., 500°F. and 550°F., respectively, six passes were applied in this manner resulting in an insulation build of approximately 1.9 mils.

450 grams of zinc oxide (ZnO) particulate filler having an average particle size of 0.12 microns and a surface area of 90 square meters per gram was added to 2,584 grams of a polyarylsulfone magnet wire enamel comprising 21% weight resin in a commercially available cresol, phenol and aromatic hydrocarbon solvent were  
5 intimately mixed by a conventional ball mill to disperse the particulate filler throughout the enamel. The resultant enamel was then applied to the previously insulated magnet wire conductor having a continuous, concentric and flexible uniform coat of base insulation material thereon by employing dyes and a conventional magnet wire coating tower at 16 meters per minute, having temperatures of  
10 450°F., 500°F. and 550°F., respectively, 2 passes were applied in this manner to place on the previously insulated conductor the pulsed voltage surge shield of the invention resulting in an insulation build of approximately 0.4 mils.

A conventional amide imide magnet wire enamel comprising 28% weight resin in a N-methyl pyrrolidone and aromatic hydrocarbon solvent was then applied  
15 over the previously insulated conductor having both a continuous, concentric, flexible and uniform coat of base insulation material thereon. The pulsed voltage surge shield of the invention superimposed thereon by employing dyes and a conventional magnet wire coating tower at 36 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively. Two passes were applied  
20 in this manner resulting in an insulation build of approximately 0.6 to 0.8 mils.

The properties of the resultant magnet wire are shown in Table I.

#### Example XXXII

A polyarylsulfone magnet wire enamel comprising 21% weight resin in  
25 commercially available cresol, phenol and aromatic hydrocarbon solvent as applied to a bare 18 AWG copper magnet wire conductor having no insulation thereon employing dyes in a conventional magnet wire coating tower at 16 meters per minute having temperatures of 450°F., 500°F. and 550°F., respectively, six passes  
30 were applied in this manner resulting in an insulation build of approximately 1.9 mils.

900 grams of zinc oxide (ZnO) particulate filler having an average particle size of 0.12 microns and a surface area of 90 square meters per gram was added to 2,584 grams of a polyarylsulfone magnet wire enamel comprising 21% weight resin in a commercially available cresol, phenol and aromatic hydrocarbon solvent were  
35 intimately mixed by a conventional ball mill to disperse the particulate filler

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throughout the enamel. The resultant enamel was then applied to the previously insulated magnet wire conductor having a continuous, concentric and flexible uniform coat of base insulation material thereon by employing dyes and a conventional magnet wire coating tower at 16 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively, 2 passes were applied in this manner to place on the previously insulated conductor the pulsed voltage surge shield of the invention resulting in an insulation build of approximately 0.4 mils.

A conventional NYLON magnet wire enamel comprising 20% resin weight in a phenol, cresol and aromatic hydrocarbon solvent was then applied over the previously insulated conductor having both a continuous, concentric, flexible and uniform coat of base insulation material thereon and the pulsed voltage surge shield of the invention superimposed thereon by employing dyes and a conventional magnet wire coating tower at 31 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively. Two passes were applied in this manner resulting in an insulation build of approximately 0.6 to 0.8 mils.

The properties of the resultant magnet wire are shown in Table I.

#### Example XXXIII

A polyarylsulfone magnet wire enamel comprising 21% weight resin in commercially available cresol, phenol and aromatic hydrocarbon solvent as applied to a bare 18 AWG copper magnet wire conductor having no insulation thereon employing dyes in a conventional magnet wire coating tower at 16 meters per minute having temperatures of 450°F., 500°F. and 550°F., respectively, twelve passes were applied in this manner resulting in an insulation build of approximately 3.0 mils.

The properties of the resultant magnet wire are shown in Table I.

#### Example XXXIV

A polyarylsulfone magnet wire enamel comprising 21% weight resin in commercially available cresol, phenol and aromatic hydrocarbon solvent as applied to a bare 18 AWG copper magnet wire conductor having no insulation thereon employing dyes in a conventional magnet wire coating tower at 16 meters per minute having temperatures of 450°F., 500°F. and 550°F., respectively, eight passes were applied in this manner resulting in an insulation build of approximately 1.9 mils.

A conventional NYLON magnet wire enamel comprising 20% resin weight in a phenol, cresol and aromatic hydrocarbon solvent was then applied over the previously insulated conductor having both a continuous, concentric, flexible and uniform coat of base insulation material thereon and the pulsed voltage surge shield of the invention superimposed thereon by employing dyes and a conventional magnet wire coating tower at 31 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively. Two passes were applied in this manner resulting in an insulation build of approximately 0.6 to 0.8 mils.

The properties of the resultant magnet wire are shown in Table I.

#### Example XXXV

A polyarylsulfone magnet wire enamel comprising 21% weight resin in commercially available cresol, phenol and aromatic hydrocarbon solvent as applied to a bare 18 AWG copper magnet wire conductor having no insulation thereon employing dyes in a conventional magnet wire coating tower at 16 meters per minute having temperatures of 450°F., 500°F. and 550°F., respectively, six passes were applied in this manner resulting in an insulation build of approximately 1.8 mils.

1,677 grams of equal parts of fumed titanium dioxide, fumed alumina and zinc oxide particulate filler having an average particle size of 0.016 microns and an average surface area of 92 square meters per gram was added to 2,580 grams of a polyarylsulfone magnet wire enamel comprising 21% weight resin in a commercially available cresol, phenol and aromatic hydrocarbon solvent were intimately mixed by stirring at high speed to disperse the particulate filler throughout the enamel. The resultant enamel was then applied to the previously insulated magnet wire conductor having a continuous, concentric and flexible uniform coat of base insulation material thereon by employing dyes and a conventional magnet wire coating tower at 16 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively, 2 passes were applied in this manner to place on the previously insulated conductor the pulsed voltage surge shield of the invention resulting in an insulation build of approximately 0.4 mils.

A conventional NYLON magnet wire enamel comprising 20% resin weight in a phenol, cresol and aromatic hydrocarbon solvent was then applied over the previously insulated conductor having both a continuous, concentric, flexible and uniform coat of base insulation material thereon and the pulsed voltage surge

shield of the invention superimposed thereon by employing dyes and a conventional magnet wire coating tower at 31 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively. Two passes were applied in this manner resulting in an insulation build of approximately 0.6 to 0.8 mils.

5       The properties of the resultant magnet wire are shown in Table I.

#### Example XXXVI

10       A polyarylsulfone magnet wire enamel comprising 21% weight resin in commercially available cresol, phenol and aromatic hydrocarbon solvent as applied to a bare 18 AWG copper magnet wire conductor having no insulation thereon employing dyes in a conventional magnet wire coating tower at 16 meters per minute having temperatures of 450°F., 500°F. and 550°F., respectively, six passes were applied in this manner resulting in an insulation build of approximately 1.8 mils.

15       837 grams of equal parts of fumed titanium dioxide, fumed alumina and zinc oxide particulate filler having an average particle size of 0.016 microns and an average surface area of 92 square meters per gram was added to 2,580 grams of a polyarylsulfone magnet wire enamel comprising 21% weight resin in a commercially available cresol, phenol and aromatic hydrocarbon solvent were intimately  
20 mixed by stirring at high speed to disperse the particulate filler throughout the enamel. The resultant enamel was then applied to the previously insulated magnet wire conductor having a continuous, concentric and flexible uniform coat of base insulation material thereon by employing dyes and a conventional magnet wire coating tower at 16 meters per minute, having temperatures of 450°F., 500°F. and  
25 550°F., respectively, 2 passes were applied in this manner to place on the previously insulated conductor the pulsed voltage surge shield of the invention resulting in an insulation build of approximately 0.4 mils.

30       A conventional amide imide magnet wire enamel comprising 28% weight resin in a N-methyl pyrrolidone and aromatic hydrocarbon solvent was then applied over the previously insulated conductor having both a continuous, concentric, flexible and uniform coat of base insulation material thereon. The pulsed voltage surge shield of the invention superimposed thereon by employing dyes and a conventional magnet wire coating tower at 36 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively. Two passes were applied  
35 in this manner resulting in an insulation build of approximately 0.6 to 0.8 mils.

The properties of the resultant magnet wire are shown in Table I.

#### Example XXXVII

5 A polyarylsulfone magnet wire enamel comprising 21% weight resin in commercially available cresol, phenol and aromatic hydrocarbon solvent as applied to a bare 18 AWG copper magnet wire conductor having no insulation thereon employing dyes in a conventional magnet wire coating tower at 16 meters per minute having temperatures of 450°F., 500°F. and 550°F., respectively, six passes were applied in this manner resulting in an insulation build of approximately 1.8  
10 mils.

140 grams of equal parts of fumed titanium dioxide, fumed alumina and zinc oxide particulate filler having an average particle size of 0.016 microns and an average surface area of 92 square meters per gram was added to 2,580 grams of a polyarylsulfone magnet wire enamel comprising 21% weight resin in a commercially available cresol, phenol and aromatic hydrocarbon solvent were intimately mixed by stirring at high speed to disperse the particulate filler throughout the enamel. The resultant enamel was then applied to the previously insulated magnet wire conductor having a continuous, concentric and flexible uniform coat of base insulation material thereon by employing dyes and a conventional magnet wire  
15 coating tower at 16 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively, 2 passes were applied in this manner to place on the previously insulated conductor the pulsed voltage surge shield of the invention resulting in an insulation build of approximately 0.4 mils.  
20

A conventional NYLON magnet wire enamel comprising 20% resin weight in a phenol, cresol and aromatic hydrocarbon solvent was then applied over the previously insulated conductor having both a continuous, concentric, flexible and uniform coat of base insulation material thereon and the pulsed voltage surge shield of the invention superimposed thereon by employing dyes and a conventional magnet wire coating tower at 31 meters per minute, having  
25 temperatures of 450°F., 500°F. and 550°F., respectively. Two passes were applied in this manner resulting in an insulation build of approximately 0.6 to 0.8 mils.  
30

The properties of the resultant magnet wire are shown in Table I.

#### Example XXXVIII

A polyarylsulfone magnet wire enamel comprising 21% weight resin in commercially available cresol, phenol and aromatic hydrocarbon solvent as applied to a bare 18 AWG copper magnet wire conductor having no insulation thereon employing dyes in a conventional magnet wire coating tower at 16 meters per minute having temperatures of 450°F., 500°F. and 550°F., respectively, six passes were applied in this manner resulting in an insulation build of approximately 1.8 mils.

75 grams of WC-426 clay particulate filler having an average particle size of 0.7 microns and a surface area of 13 to about 17 square meters per gram was added to 1,500 grams of a polyarylsulfone magnet wire enamel comprising 21% weight resin in a commercially available cresol, phenol and aromatic hydrocarbon solvent were intimately mixed by a conventional ball mill to disperse the particulate filler throughout the enamel. The resultant enamel was then applied to the previously insulated magnet wire conductor having a continuous, concentric and flexible uniform coat of base insulation material thereon by employing dyes and a conventional magnet wire coating tower at 16 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively, 2 passes were applied in this manner to place on the previously insulated conductor the pulsed voltage surge shield of the invention resulting in an insulation build of approximately 0.4 mils.

A conventional amide imide magnet wire enamel comprising 28% weight resin in a N-methyl pyrrolidone and aromatic hydrocarbon solvent was then applied over the previously insulated conductor having both a continuous, concentric, flexible and uniform coat of base insulation material thereon. The pulsed voltage surge shield of the invention superimposed thereon by employing dyes and a conventional magnet wire coating tower at 36 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively. Two passes were applied in this manner resulting in an insulation build of approximately 0.6 to 0.8 mils.

The properties of the resultant magnet wire are shown in Table I.

#### Example XXXIX

A polyarylsulfone magnet wire enamel comprising 21% weight resin in commercially available cresol, phenol and aromatic hydrocarbon solvent as applied to a bare 18 AWG copper magnet wire conductor having no insulation thereon employing dyes in a conventional magnet wire coating tower at 16 meters per minute having temperatures of 450°F., 500°F. and 550°F., respectively, six passes

were applied in this manner resulting in an insulation build of approximately 1.8 mils.

450 grams of WC-426 clay particulate filler having an average particle size of 0.7 microns and a surface area of 13 to about 17 square meters per gram was added to 1,500 grams of a polyarylsulfone magnet wire enamel comprising 21% weight resin in a commercially available cresol, phenol and aromatic hydrocarbon solvent were intimately mixed by a conventional ball mill to disperse the particulate filler throughout the enamel. The resultant enamel was then applied to the previously insulated magnet wire conductor having a continuous, concentric and flexible uniform coat of base insulation material thereon by employing dyes and a conventional magnet wire coating tower at 16 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively, 2 passes were applied in this manner to place on the previously insulated conductor the pulsed voltage surge shield of the invention resulting in an insulation build of approximately 0.4 mils.

A conventional NYLON magnet wire enamel comprising 20% resin weight in a phenol, cresol and aromatic hydrocarbon solvent was then applied over the previously insulated conductor having both a continuous, concentric, flexible and uniform coat of base insulation material thereon and the pulsed voltage surge shield of the invention superimposed thereon by employing dyes and a conventional magnet wire coating tower at 31 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively. Two passes were applied in this manner resulting in an insulation build of approximately 0.6 to 0.8 mils.

The properties of the resultant magnet wire are shown in Table I.

#### Example XL

A conventional polyester magnet wire enamel comprising 38.2% weight resin in commercially available cresol, phenol and aromatic hydrocarbon solvent as applied to a bare 18 AWG copper magnet wire conductor having no insulation thereon employing dyes in a conventional magnet wire coating tower at 34 meters per minute having temperatures of 450°F., 500°F. and 550°F., respectively, six passes were applied in this manner resulting in an insulation build of approximately 1.8 mils.

60 grams of iron oxide (Fe<sub>2</sub>O<sub>3</sub>) particulate filler having an average particle size of 0.09 microns was added to 1,200 grams of a conventional polyester magnet

wire enamel comprising 38.2% weight resin in a commercially available cresol, phenol and aromatic hydrocarbon solvent were intimately mixed by stirring at high speed to disperse the particulate filler throughout the enamel. The resultant enamel was then applied to the previously insulated magnet wire conductor having a continuous, concentric and flexible uniform coat of base insulation material thereon by employing dyes and a conventional magnet wire coating tower at 34 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively, 2 passes were applied in this manner to place on the previously insulated conductor the pulsed voltage surge shield of the invention resulting in an insulation build of approximately 0.4 mils.

A conventional amide imide magnet wire enamel comprising 28% weight resin in a N-methyl pyrrolidone and aromatic hydrocarbon solvent was then applied over the previously insulated conductor having both a continuous, concentric, flexible and uniform coat of base insulation material thereon. The pulsed voltage surge shield of the invention superimposed thereon by employing dyes and a conventional magnet wire coating tower at 36 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively. Two passes were applied in this manner resulting in an insulation build of approximately 0.6 to 0.8 mils.

The properties of the resultant magnet wire are shown in Table I.

#### Example XLI

A conventional polyester magnet wire enamel comprising 38.2% weight resin in commercially available cresol, phenol and aromatic hydrocarbon solvent as applied to a bare 18 AWG copper magnet wire conductor having no insulation thereon employing dyes in a conventional magnet wire coating tower at 34 meters per minute having temperatures of 450°F., 500°F. and 550°F., respectively, six passes were applied in this manner resulting in an insulation build of approximately 1.8 mils.

120 grams of iron oxide (Fe<sub>2</sub>O<sub>3</sub>) particulate filler having an average particle size of 0.09 microns was added to 1,200 grams of a conventional polyester magnet wire enamel comprising 38.2% weight resin in a commercially available cresol, phenol and aromatic hydrocarbon solvent were intimately mixed by stirring at high speed to disperse the particulate filler throughout the enamel. The resultant enamel was then applied to the previously insulated magnet wire conductor having a continuous, concentric and flexible uniform coat of base insulation material

thereon by employing dyes and a conventional magnet wire coating tower at 34 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively, 2 passes were applied in this manner to place on the previously insulated conductor the pulsed voltage surge shield of the invention resulting in an insulation build of approximately 0.4 mils.

A conventional NYLON magnet wire enamel comprising 20% resin weight in a phenol, cresol and aromatic hydrocarbon solvent was then applied over the previously insulated conductor having both a continuous, concentric, flexible and uniform coat of base insulation material thereon and the pulsed voltage surge shield of the invention superimposed thereon by employing dyes and a conventional magnet wire coating tower at 31 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively. Two passes were applied in this manner resulting in an insulation build of approximately 0.6 to 0.8 mils.

The properties of the resultant magnet wire are shown in Table I.

#### Example XLII

A conventional polyester magnet wire enamel comprising 38.2% weight resin in commercially available cresol, phenol and aromatic hydrocarbon solvent as applied to a bare 18 AWG copper magnet wire conductor having no insulation thereon employing dyes in a conventional magnet wire coating tower at 34 meters per minute having temperatures of 450°F., 500°F. and 550°F., respectively, six passes were applied in this manner resulting in an insulation build of approximately 1.8 mils.

240 grams of iron oxide (Fe<sub>2</sub>O<sub>3</sub>) particulate filler having an average particle size of 0.09 microns was added to 1,200 grams of a conventional polyester magnet wire enamel comprising 38.2% weight resin in a commercially available cresol, phenol and aromatic hydrocarbon solvent were intimately mixed by stirring at high speed to disperse the particulate filler throughout the enamel. The resultant enamel was then applied to the previously insulated magnet wire conductor having a continuous, concentric and flexible uniform coat of base insulation material thereon by employing dyes and a conventional magnet wire coating tower at 34 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively, 2 passes were applied in this manner to place on the previously insulated conductor the pulsed voltage surge shield of the invention resulting in an insulation build of approximately 0.4 mils.

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A conventional amide imide magnet wire enamel comprising 28% weight resin in a N-methyl pyrrolidone and aromatic hydrocarbon solvent was then applied over the previously insulated conductor having both a continuous, concentric, flexible and uniform coat of base insulation material thereon. The pulsed voltage surge shield of the invention superimposed thereon by employing dyes and a conventional magnet wire coating tower at 36 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively. Two passes were applied in this manner resulting in an insulation build of approximately 0.6 to 0.8 mils.

The properties of the resultant magnet wire are shown in Table I.

#### Example XLIII

A conventional polyester magnet wire enamel comprising 38.2% weight resin in commercially available cresol, phenol and aromatic hydrocarbon solvent as applied to a bare 18 AWG copper magnet wire conductor having no insulation thereon employing dyes in a conventional magnet wire coating tower at 34 meters per minute having temperatures of 450°F., 500°F. and 550°F., respectively, six passes were applied in this manner resulting in an insulation build of approximately 1.8 mils.

60 grams of fumed zirconium oxide ( $Zr_2O_3$ ) particulate filler having an average particle size of 0.03 microns and a surface area of about 30 to 50 square meters per gram was added to 1,200 grams of a conventional polyester magnet wire enamel comprising 38.2% weight resin in a commercially available cresol, phenol and aromatic hydrocarbon solvent were intimately mixed by stirring at high speed to disperse the particulate filler throughout the enamel. The resultant enamel was then applied to the previously insulated magnet wire conductor having a continuous, concentric and flexible uniform coat of base insulation material thereon by employing dyes and a conventional magnet wire coating tower at 34 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively, 2 passes were applied in this manner to place on the previously insulated conductor the pulsed voltage surge shield of the invention resulting in an insulation build of approximately 0.4 mils.

A conventional NYLON magnet wire enamel comprising 20% resin weight in a phenol, cresol and aromatic hydrocarbon solvent was then applied over the previously insulated conductor having both a continuous, concentric, flexible and uniform coat of base insulation material thereon and the pulsed voltage surge

shield of the invention superimposed thereon by employing dyes and a conventional magnet wire coating tower at 31 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively. Two passes were applied in this manner resulting in an insulation build of approximately 0.6 to 0.8 mils.

5 The properties of the resultant magnet wire are shown in Table I.

#### Example XLIV

10 A conventional polyester magnet wire enamel comprising 38.2% weight resin in commercially available cresol, phenol and aromatic hydrocarbon solvent as applied to a bare 18 AWG copper magnet wire conductor having no insulation thereon employing dyes in a conventional magnet wire coating tower at 34 meters per minute having temperatures of 450°F., 500°F. and 550°F., respectively, six passes were applied in this manner resulting in an insulation build of approximately 1.8 mils.

15 126 grams of fumed zirconium oxide ( $Zr_2O_3$ ) particulate filler having an average particle size of 0.03 microns and a surface area of about 30 to 50 square meters per gram was added to 1,200 grams of a conventional polyester magnet wire enamel comprising 38.2% weight resin in a commercially available cresol, phenol and aromatic hydrocarbon solvent were intimately mixed by stirring at high speed  
20 to disperse the particulate filler throughout the enamel. The resultant enamel was then applied to the previously insulated magnet wire conductor having a continuous, concentric and flexible uniform coat of base insulation material thereon by employing dyes and a conventional magnet wire coating tower at 34 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively,  
25 2 passes were applied in this manner to place on the previously insulated conductor the pulsed voltage surge shield of the invention resulting in an insulation build of approximately 0.4 mils.

30 A conventional amide imide magnet wire enamel comprising 28% weight resin in a N-methyl pyrrolidone and aromatic hydrocarbon solvent was then applied over the previously insulated conductor having both a continuous, concentric, flexible and uniform coat of base insulation material thereon. The pulsed voltage surge shield of the invention superimposed thereon by employing dyes and a conventional magnet wire coating tower at 36 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively. Two passes were applied  
35 in this manner resulting in an insulation build of approximately 0.6 to 0.8 mils.

The properties of the resultant magnet wire are shown in Table I.

#### Example XLV

5 A conventional polyester magnet wire enamel comprising 38.2% weight resin  
in commercially available cresol, phenol and aromatic hydrocarbon solvent as  
applied to a bare 18 AWG copper magnet wire conductor having no insulation  
thereon employing dyes in a conventional magnet wire coating tower at 34 meters  
per minute having temperatures of 450°F., 500°F. and 550°F., respectively, six  
10 passes were applied in this manner resulting in an insulation build of  
approximately 1.8 mils.

240 grams of fumed zirconium oxide ( $Zr_2O_3$ ) particulate filler having an  
average particle size of 0.03 microns and a surface area of about 30 to 50 square  
meters per gram was added to 1,200 grams of a conventional polyester magnet wire  
enamel comprising 38.2% weight resin in a commercially available cresol, phenol  
15 and aromatic hydrocarbon solvent were intimately mixed by stirring at high speed  
to disperse the particulate filler throughout the enamel. The resultant enamel was  
then applied to the previously insulated magnet wire conductor having a  
continuous, concentric and flexible uniform coat of base insulation material  
thereon by employing dyes and a conventional magnet wire coating tower at 34  
20 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively,  
2 passes were applied in this manner to place on the previously insulated  
conductor the pulsed voltage surge shield of the invention resulting in an  
insulation build of approximately 0.4 mils.

A conventional NYLON magnet wire enamel comprising 20% resin weight in  
25 a phenol, cresol and aromatic hydrocarbon solvent was then applied over the  
previously insulated conductor having both a continuous, concentric, flexible and  
uniform coat of base insulation material thereon and the pulsed voltage surge  
shield of the invention superimposed thereon by employing dyes and a  
conventional magnet wire coating tower at 31 meters per minute, having  
30 temperatures of 450°F., 500°F. and 550°F., respectively. Two passes were applied  
in this manner resulting in an insulation build of approximately 0.6 to 0.8 mils.

The properties of the resultant magnet wire are shown in Table I.

#### Example XLVI

A conventional FORMVAR magnet wire enamel comprising 16% weight resin in commercially available cresol, phenol and aromatic hydrocarbon solvent as applied to a bare 18 AWG copper magnet wire conductor having no insulation thereon employing dyes in a conventional magnet wire coating tower at 32 meters per minute having temperatures of 450°F., 500°F. and 550°F., respectively, six passes were applied in this manner resulting in an insulation build of approximately 1.8 mils.

25 grams of fumed titanium dioxide ( $\text{TiO}_2$ ) particulate filler having an average particle size of 0.021 microns and a surface area of 35 square meters per gram was added to 1,200 grams of a conventional FORMVAR magnet wire enamel comprising 16% weight resin in a commercially available cresol, phenol and aromatic hydrocarbon solvent were intimately mixed by stirring at high speed to disperse the particulate filler throughout the enamel. The resultant enamel was then applied to the previously insulated magnet wire conductor having a continuous, concentric and flexible uniform coat of base insulation material thereon by employing dyes and a conventional magnet wire coating tower at 32 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively, 2 passes were applied in this manner to place on the previously insulated conductor the pulsed voltage surge shield of the invention resulting in an insulation build of approximately 0.4 mils.

A conventional amide imide magnet wire enamel comprising 28% weight resin in a N-methyl pyrrolidone and aromatic hydrocarbon solvent was then applied over the previously insulated conductor having both a continuous, concentric, flexible and uniform coat of base insulation material thereon. The pulsed voltage surge shield of the invention superimposed thereon by employing dyes and a conventional magnet wire coating tower at 36 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively. Two passes were applied in this manner resulting in an insulation build of approximately 0.6 to 0.8 mils.

The properties of the resultant magnet wire are shown in Table I.

#### Example XLVII

A conventional FORMVAR magnet wire enamel comprising 16% weight resin in commercially available cresol, phenol and aromatic hydrocarbon solvent as applied to a bare 18 AWG copper magnet wire conductor having no insulation

thereon employing dyes in a conventional magnet wire coating tower at 32 meters per minute having temperatures of 450°F., 500°F. and 550°F., respectively, six passes were applied in this manner resulting in an insulation build of approximately 1.8 mils.

5        75 grams of fumed titanium dioxide ( $\text{TiO}_2$ ) particulate filler having an average particle size of 0.021 microns and a surface area of 35 square meters per gram was added to 1,200 grams of a conventional FORMVAR magnet wire enamel comprising 16% weight resin in a commercially available cresol, phenol and aromatic hydrocarbon solvent were intimately mixed by stirring at high speed to disperse the  
10        particulate filler throughout the enamel. The resultant enamel was then applied to the previously insulated magnet wire conductor having a continuous, concentric and flexible uniform coat of base insulation material thereon by employing dyes and a conventional magnet wire coating tower at 32 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively, 2 passes were applied in  
15        this manner to place on the previously insulated conductor the pulsed voltage surge shield of the invention resulting in an insulation build of approximately 0.4 mils.

A conventional NYLON magnet wire enamel comprising 20% resin weight in a phenol, cresol and aromatic hydrocarbon solvent was then applied over the  
20        previously insulated conductor having both a continuous, concentric, flexible and uniform coat of base insulation material thereon and the pulsed voltage surge shield of the invention superimposed thereon by employing dyes and a conventional magnet wire coating tower at 31 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively. Two passes were applied  
25        in this manner resulting in an insulation build of approximately 0.6 to 0.8 mils.

The properties of the resultant magnet wire are shown in Table I.

#### Example XLVIII

A conventional FORMVAR magnet wire enamel comprising 16% weight resin  
30        in commercially available cresol, phenol and aromatic hydrocarbon solvent as applied to a bare 18 AWG copper magnet wire conductor having no insulation thereon employing dyes in a conventional magnet wire coating tower at 32 meters per minute having temperatures of 450°F., 500°F. and 550°F., respectively, six passes were applied in this manner resulting in an insulation build of  
35        approximately 1.8 mils.

150 grams of fumed titanium dioxide ( $\text{TiO}_2$ ) particulate filler having an average particle size of 0.021 microns and a surface area of 35 square meters per gram was added to 1,200 grams of a conventional FORMVAR magnet wire enamel comprising 16% weight resin in a commercially available cresol, phenol and aromatic hydrocarbon solvent were intimately mixed by stirring at high speed to disperse the particulate filler throughout the enamel. The resultant enamel was then applied to the previously insulated magnet wire conductor having a continuous, concentric and flexible uniform coat of base insulation material thereon by employing dyes and a conventional magnet wire coating tower at 32 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively, 2 passes were applied in this manner to place on the previously insulated conductor the pulsed voltage surge shield of the invention resulting in an insulation build of approximately 0.4 mils.

A conventional amide imide magnet wire enamel comprising 28% weight resin in a N-methyl pyrrolidone and aromatic hydrocarbon solvent was then applied over the previously insulated conductor having both a continuous, concentric, flexible and uniform coat of base insulation material thereon. The pulsed voltage surge shield of the invention superimposed thereon by employing dyes and a conventional magnet wire coating tower at 36 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively. Two passes were applied in this manner resulting in an insulation build of approximately 0.6 to 0.8 mils.

The properties of the resultant magnet wire are shown in Table I.

#### Example XLIX

A conventional FORMVAR magnet wire enamel comprising 16% weight resin in commercially available cresol, phenol and aromatic hydrocarbon solvent as applied to a bare 18 AWG copper magnet wire conductor having no insulation thereon employing dyes in a conventional magnet wire coating tower at 32 meters per minute having temperatures of 450°F., 500°F. and 550°F., respectively, six passes were applied in this manner resulting in an insulation build of approximately 1.8 mils.

27 grams of fumed alumina ( $\text{Al}_2\text{O}_3$ ) particulate filler having an average particle size of 0.013 microns and a surface area of 85 square meters per gram was added to 1,000 grams of a conventional FORMVAR magnet wire enamel comprising 16% weight resin in a commercially available cresol, phenol and aromatic hydrocar-

bon solvent were intimately mixed by stirring at high speed to disperse the particulate filler throughout the enamel. The resultant enamel was then applied to the previously insulated magnet wire conductor having a continuous, concentric and flexible uniform coat of base insulation material thereon by employing dyes and a conventional magnet wire coating tower at 32 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively, 2 passes were applied in this manner to place on the previously insulated conductor the pulsed voltage surge shield of the invention resulting in an insulation build of approximately 0.4 mils.

A conventional NYLON magnet wire enamel comprising 20% resin weight in a phenol, cresol and aromatic hydrocarbon solvent was then applied over the previously insulated conductor having both a continuous, concentric, flexible and uniform coat of base insulation material thereon and the pulsed voltage surge shield of the invention superimposed thereon by employing dyes and a conventional magnet wire coating tower at 31 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively. Two passes were applied in this manner resulting in an insulation build of approximately 0.6 to 0.8 mils.

The properties of the resultant magnet wire are shown in Table I.

#### Example L

A conventional FORMVAR magnet wire enamel comprising 16% weight resin in commercially available cresol, phenol and aromatic hydrocarbon solvent as applied to a bare 18 AWG copper magnet wire conductor having no insulation thereon employing dyes in a conventional magnet wire coating tower at 32 meters per minute having temperatures of 450°F., 500°F. and 550°F., respectively, six passes were applied in this manner resulting in an insulation build of approximately 1.8 mils.

80 grams of fumed alumina ( $Al_2O_3$ ) particulate filler having an average particle size of 0.013 microns and a surface area of 85 square meters per gram was added to 1,000 grams of a conventional FORMVAR magnet wire enamel comprising 16% weight resin in a commercially available cresol, phenol and aromatic hydrocarbon solvent were intimately mixed by stirring at high speed to disperse the particulate filler throughout the enamel. The resultant enamel was then applied to the previously insulated magnet wire conductor having a continuous, concentric and flexible uniform coat of base insulation material thereon by employing dyes

and a conventional magnet wire coating tower at 32 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively, 2 passes were applied in this manner to place on the previously insulated conductor the pulsed voltage surge shield of the invention resulting in an insulation build of approximately 0.4 mils.

A conventional amide imide magnet wire enamel comprising 28% weight resin in a N-methyl pyrrolidone and aromatic hydrocarbon solvent was then applied over the previously insulated conductor having both a continuous, concentric, flexible and uniform coat of base insulation material thereon. The pulsed voltage surge shield of the invention superimposed thereon by employing dyes and a conventional magnet wire coating tower at 36 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively. Two passes were applied in this manner resulting in an insulation build of approximately 0.6 to 0.8 mils.

The properties of the resultant magnet wire are shown in Table I.

#### Example LI

A conventional FORMVAR magnet wire enamel comprising 16% weight resin in commercially available cresol, phenol and aromatic hydrocarbon solvent as applied to a bare 18 AWG copper magnet wire conductor having no insulation thereon employing dyes in a conventional magnet wire coating tower at 32 meters per minute having temperatures of 450°F., 500°F. and 550°F., respectively, six passes were applied in this manner resulting in an insulation build of approximately 1.8 mils.

160 grams of fumed alumina ( $Al_2O_3$ ) particulate filler having an average particle size of 0.013 microns and a surface area of 85 square meters per gram was added to 1,000 grams of a conventional FORMVAR magnet wire enamel comprising 16% weight resin in a commercially available cresol, phenol and aromatic hydrocarbon solvent were intimately mixed by stirring at high speed to disperse the particulate filler throughout the enamel. The resultant enamel was then applied to the previously insulated magnet wire conductor having a continuous, concentric and flexible uniform coat of base insulation material thereon by employing dyes and a conventional magnet wire coating tower at 32 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively, 2 passes were applied in this manner to place on the previously insulated conductor the pulsed voltage



surge shield of the invention resulting in an insulation build of approximately 0.4 mils.

A conventional NYLON magnet wire enamel comprising 20% resin weight in a phenol, cresol and aromatic hydrocarbon solvent was then applied over the previously insulated conductor having both a continuous, concentric, flexible and uniform coat of base insulation material thereon and the pulsed voltage surge shield of the invention superimposed thereon by employing dyes and a conventional magnet wire coating tower at 31 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively. Two passes were applied in this manner resulting in an insulation build of approximately 0.6 to 0.8 mils.

The properties of the resultant magnet wire are shown in Table I.

#### Example LII

A conventional FORMVAR magnet wire enamel comprising 16% weight resin in commercially available cresol, phenol and aromatic hydrocarbon solvent as applied to a bare 18 AWG copper magnet wire conductor having no insulation thereon employing dyes in a conventional magnet wire coating tower at 32 meters per minute having temperatures of 450°F., 500°F. and 550°F., respectively, six passes were applied in this manner resulting in an insulation build of approximately 1.8 mils.

10 grams of fumed silica ( $\text{SiO}_2$ ) particulate filler having an average particle size of 0.016 microns and a surface area of about 90 to about 130 square meters per gram was added to 1,600 grams of a conventional FORMVAR magnet wire enamel comprising 16% weight resin in a commercially available cresol, phenol and aromatic hydrocarbon solvent were intimately mixed by stirring at high speed to disperse the particulate filler throughout the enamel. The resultant enamel was then applied to the previously insulated magnet wire conductor having a continuous, concentric and flexible uniform coat of base insulation material thereon by employing dyes and a conventional magnet wire coating tower at 32 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively, 2 passes were applied in this manner to place on the previously insulated conductor the pulsed voltage surge shield of the invention resulting in an insulation build of approximately 0.4 mils.

A conventional amide imide magnet wire enamel comprising 28% weight resin in a N-methyl pyrrolidone and aromatic hydrocarbon solvent was then applied

over the previously insulated conductor having both a continuous, concentric, flexible and uniform coat of base insulation material thereon. The pulsed voltage surge shield of the invention superimposed thereon by employing dyes and a conventional magnet wire coating tower at 36 meters per minute, having

5 temperatures of 450°F., 500°F. and 550°F., respectively. Two passes were applied in this manner resulting in an insulation build of approximately 0.6 to 0.8 mils.

The properties of the resultant magnet wire are shown in Table I.

#### Example LIII

10 A conventional FORMVAR magnet wire enamel comprising 16% weight resin in commercially available cresol, phenol and aromatic hydrocarbon solvent as applied to a bare 18 AWG copper magnet wire conductor having no insulation thereon employing dyes in a conventional magnet wire coating tower at 32 meters per minute having temperatures of 450°F., 500°F. and 550°F., respectively, six

15 passes were applied in this manner resulting in an insulation build of approximately 1.8 mils.

25 grams of fumed silica ( $\text{SiO}_2$ ) particulate filler having an average particle size of 0.016 microns and a surface area of about 90 to about 130 square meters per gram was added to 1,600 grams of a conventional FORMVAR magnet wire

20 enamel comprising 16% weight resin in a commercially available cresol, phenol and aromatic hydrocarbon solvent were intimately mixed by stirring at high speed to disperse the particulate filler throughout the enamel. The resultant enamel was then applied to the previously insulated magnet wire conductor having a continuous, concentric and flexible uniform coat of base insulation material

25 thereon by employing dyes and a conventional magnet wire coating tower at 32 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively, 2 passes were applied in this manner to place on the previously insulated conductor the pulsed voltage surge shield of the invention resulting in an insulation build of approximately 0.4 mils.

30 A conventional NYLON magnet wire enamel comprising 20% resin weight in a phenol, cresol and aromatic hydrocarbon solvent was then applied over the previously insulated conductor having both a continuous, concentric, flexible and uniform coat of base insulation material thereon and the pulsed voltage surge shield of the invention superimposed thereon by employing dyes and a

35 conventional magnet wire coating tower at 31 meters per minute, having

temperatures of 450°F., 500°F. and 550°F., respectively. Two passes were applied in this manner resulting in an insulation build of approximately 0.6 to 0.8 mils.

The properties of the resultant magnet wire are shown in Table I.

#### 5 Example LIV

A conventional FORMVAR magnet wire enamel comprising 16% weight resin in commercially available cresol, phenol and aromatic hydrocarbon solvent as applied to a bare 18 AWG copper magnet wire conductor having no insulation thereon employing dyes in a conventional magnet wire coating tower at 32 meters  
10 per minute having temperatures of 450°F., 500°F. and 550°F., respectively, six passes were applied in this manner resulting in an insulation build of approximately 1.8 mils.

50 grams of fumed silica ( $\text{SiO}_2$ ) particulate filler having an average particle size of 0.016 microns and a surface area of about 90 to about 130 square meters  
15 per gram was added to 1,600 grams of a conventional FORMVAR magnet wire enamel comprising 16% weight resin in a commercially available cresol, phenol and aromatic hydrocarbon solvent were intimately mixed by stirring at high speed to disperse the particulate filler throughout the enamel. The resultant enamel was then applied to the previously insulated magnet wire conductor having a  
20 continuous, concentric and flexible uniform coat of base insulation material thereon by employing dyes and a conventional magnet wire coating tower at 32 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively, 2 passes were applied in this manner to place on the previously insulated conductor the pulsed voltage surge shield of the invention resulting in an  
25 insulation build of approximately 0.4 mils.

A conventional amide imide magnet wire enamel comprising 28% weight resin in a N-methyl pyrrolidone and aromatic hydrocarbon solvent was than applied over the previously insulated conductor having both a continuous, concentric, flexible and uniform coat of base insulation material thereon. The pulsed voltage  
30 surge shield of the invention superimposed thereon by employing dyes and a conventional magnet wire coating tower at 36 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively. Two passes were applied in this manner resulting in an insulation build of approximately 0.6 to 0.8 mils.

The properties of the resultant magnet wire are shown in Table I.

## Example LV

A conventional FORMVAR magnet wire enamel comprising 16% weight resin in commercially available cresol, phenol and aromatic hydrocarbon solvent as applied to a bare 18 AWG copper magnet wire conductor having no insulation thereon employing dyes in a conventional magnet wire coating tower at 32 meters per minute having temperatures of 450°F., 500°F. and 550°F., respectively, six passes were applied in this manner resulting in an insulation build of approximately 1.8 mils.

25 grams of zinc oxide (ZnO) particulate filler having an average particle size of 0.12 microns and a surface area of 90 square meters per gram was added to 2,584 grams of a conventional FORMVAR magnet wire enamel comprising 16% weight resin in a commercially available cresol, phenol and aromatic hydrocarbon solvent were intimately mixed by stirring at high speed to disperse the particulate filler throughout the enamel. The resultant enamel was then applied to the previously insulated magnet wire conductor having a continuous, concentric and flexible uniform coat of base insulation material thereon by employing dyes and a conventional magnet wire coating tower at 32 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively, 2 passes were applied in this manner to place on the previously insulated conductor the pulsed voltage surge shield of the invention resulting in an insulation build of approximately 0.4 mils.

A conventional NYLON magnet wire enamel comprising 20% resin weight in a phenol, cresol and aromatic hydrocarbon solvent was then applied over the previously insulated conductor having both a continuous, concentric, flexible and uniform coat of base insulation material thereon and the pulsed voltage surge shield of the invention superimposed thereon by employing dyes and a conventional magnet wire coating tower at 31 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively. Two passes were applied in this manner resulting in an insulation build of approximately 0.6 to 0.8 mils.

The properties of the resultant magnet wire are shown in Table I.

## Example LVI

A conventional FORMVAR magnet wire enamel comprising 16% weight resin in commercially available cresol, phenol and aromatic hydrocarbon solvent as applied to a bare 18 AWG copper magnet wire conductor having no insulation

thereon employing dyes in a conventional magnet wire coating tower at 32 meters per minute having temperatures of 450°F., 500°F. and 550°F., respectively, six passes were applied in this manner resulting in an insulation build of approximately 1.8 mils.

5           50 grams of zinc oxide (ZnO) particulate filler having an average particle size of 0.12 microns and a surface area of 90 square meters per gram was added to 2,584 grams of a conventional FORMVAR magnet wire enamel comprising 16% weight resin in a commercially available cresol, phenol and aromatic hydrocarbon solvent were intimately mixed by stirring at high speed to disperse the particulate  
10 filler throughout the enamel. The resultant enamel was then applied to the previously insulated magnet wire conductor having a continuous, concentric and flexible uniform coat of base insulation material thereon by employing dyes and a conventional magnet wire coating tower at 32 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively, 2 passes were applied in  
15 this manner to place on the previously insulated conductor the pulsed voltage surge shield of the invention resulting in an insulation build of approximately 0.4 mils.

A conventional amide imide magnet wire enamel comprising 28% weight resin in a N-methyl pyrrolidone and aromatic hydrocarbon solvent was than applied  
20 over the previously insulated conductor having both a continuous, concentric, flexible and uniform coat of base insulation material thereon. The pulsed voltage surge shield of the invention superimposed thereon by employing dyes and a conventional magnet wire coating tower at 36 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively. Two passes were applied  
25 in this manner resulting in an insulation build of approximately 0.6 to 0.8 mils.

The properties of the resultant magnet wire are shown in Table I.

#### Example LVII

A conventional FORMVAR magnet wire enamel comprising 16% weight resin  
30 in commercially available cresol, phenol and aromatic hydrocarbon solvent as applied to a bare 18 AWG copper magnet wire conductor having no insulation thereon employing dyes in a conventional magnet wire coating tower at 32 meters per minute having temperatures of 450°F., 500°F. and 550°F., respectively, six passes were applied in this manner resulting in an insulation build of  
35 approximately 1.8 mils.

100 grams of zinc oxide (ZnO) particulate filler having an average particle size of 0.12 microns and a surface area of 90 square meters per gram was added to 2,584 grams of a conventional FORMVAR magnet wire enamel comprising 16% weight resin in a commercially available cresol, phenol and aromatic hydrocarbon solvent were intimately mixed by stirring at high speed to disperse the particulate filler throughout the enamel. The resultant enamel was then applied to the previously insulated magnet wire conductor having a continuous, concentric and flexible uniform coat of base insulation material thereon by employing dyes and a conventional magnet wire coating tower at 32 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively, 2 passes were applied in this manner to place on the previously insulated conductor the pulsed voltage surge shield of the invention resulting in an insulation build of approximately 0.4 mils.

A conventional NYLON magnet wire enamel comprising 20% resin weight in a phenol, cresol and aromatic hydrocarbon solvent was then applied over the previously insulated conductor having both a continuous, concentric, flexible and uniform coat of base insulation material thereon and the pulsed voltage surge shield of the invention superimposed thereon by employing dyes and a conventional magnet wire coating tower at 31 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively. Two passes were applied in this manner resulting in an insulation build of approximately 0.6 to 0.8 mils.

The properties of the resultant magnet wire are shown in Table I.

#### Example LVIII

A conventional FORMVAR magnet wire enamel comprising 16% weight resin in commercially available cresol, phenol and aromatic hydrocarbon solvent as applied to a bare 18 AWG copper magnet wire conductor having no insulation thereon employing dyes in a conventional magnet wire coating tower at 32 meters per minute having temperatures of 450°F., 500°F. and 550°F., respectively, twelve passes were applied in this manner resulting in an insulation build of approximately 3.0 mils.

The properties of the resultant magnet wire are shown in Table I.

#### Example LIX

A conventional FORMVAR magnet wire enamel comprising 16% weight resin in commercially available cresol, phenol and aromatic hydrocarbon solvent as applied to a bare 18 AWG copper magnet wire conductor having no insulation thereon employing dyes in a conventional magnet wire coating tower at 32 meters per minute having temperatures of 450°F., 500°F. and 550°F., respectively, eight passes were applied in this manner resulting in an insulation build of approximately 2.4 mils.

A conventional NYLON magnet wire enamel comprising 20% resin weight in a phenol, cresol and aromatic hydrocarbon solvent was then applied over the previously insulated conductor having both a continuous, concentric, flexible and uniform coat of base insulation material thereon and the pulsed voltage surge shield of the invention superimposed thereon by employing dyes and a conventional magnet wire coating tower at 31 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively. Two passes were applied in this manner resulting in an insulation build of approximately 0.6 to 0.8 mils.

The properties of the resultant magnet wire are shown in Table I.

#### Example LX

A conventional FORMVAR magnet wire enamel comprising 16% weight resin in commercially available cresol, phenol and aromatic hydrocarbon solvent as applied to a bare 18 AWG copper magnet wire conductor having no insulation thereon employing dyes in a conventional magnet wire coating tower at 32 meters per minute having temperatures of 450°F., 500°F. and 550°F., respectively, six passes were applied in this manner resulting in an insulation build of approximately 1.8 mils.

210 grams of equal parts of fumed titanium dioxide, fumed alumina and zinc oxide particulate filler having an average particle size of 0.016 microns and an average surface area of 92 square meters per gram was added to 2,580 grams of a conventional FORMVAR magnet wire enamel comprising 16% weight resin in a commercially available cresol, phenol and aromatic hydrocarbon solvent were intimately mixed by stirring at high speed to disperse the particulate filler throughout the enamel. The resultant enamel was then applied to the previously insulated magnet wire conductor having a continuous, concentric and flexible uniform coat of base insulation material thereon by employing dyes and a conventional magnet wire coating tower at 32 meters per minute, having temperatures of

450°F., 500°F. and 550°F., respectively, 2 passes were applied in this manner to place on the previously insulated conductor the pulsed voltage surge shield of the invention resulting in an insulation build of approximately 0.4 mils.

5 A conventional NYLON magnet wire enamel comprising 20% resin weight in a phenol, cresol and aromatic hydrocarbon solvent was then applied over the previously insulated conductor having both a continuous, concentric, flexible and uniform coat of base insulation material thereon and the pulsed voltage surge shield of the invention superimposed thereon by employing dyes and a conventional magnet wire coating tower at 31 meters per minute, having  
10 temperatures of 450°F., 500°F. and 550°F., respectively. Two passes were applied in this manner resulting in an insulation build of approximately 0.6 to 0.8 mils.

The properties of the resultant magnet wire are shown in Table I.

#### Example LXI

15 A conventional FORMVAR magnet wire enamel comprising 16% weight resin in commercially available cresol, phenol and aromatic hydrocarbon solvent as applied to a bare 18 AWG copper magnet wire conductor having no insulation thereon employing dyes in a conventional magnet wire coating tower at 32 meters per minute having temperatures of 450°F., 500°F. and 550°F., respectively, six  
20 passes were applied in this manner resulting in an insulation build of approximately 1.8 mils.

600 grams of equal parts of fumed titanium dioxide, fumed alumina and zinc oxide particulate filler having an average particle size of 0.016 microns and an average surface area of 92 square meters per gram was added to 2,580 grams of a  
25 conventional FORMVAR magnet wire enamel comprising 16% weight resin in a commercially available cresol, phenol and aromatic hydrocarbon solvent were intimately mixed by stirring at high speed to disperse the particulate filler throughout the enamel. The resultant enamel was then applied to the previously insulated magnet wire conductor having a continuous, concentric and flexible  
30 uniform coat of base insulation material thereon by employing dyes and a conventional magnet wire coating tower at 32 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively, 2 passes were applied in this manner to place on the previously insulated conductor the pulsed voltage surge shield of the invention resulting in an insulation build of approximately 0.4 mils.



A conventional amide imide magnet wire enamel comprising 28% weight resin in a N-methyl pyrrolidone and aromatic hydrocarbon solvent was then applied over the previously insulated conductor having both a continuous, concentric, flexible and uniform coat of base insulation material thereon. The pulsed voltage surge shield of the invention superimposed thereon by employing dyes and a conventional magnet wire coating tower at 36 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively. Two passes were applied in this manner resulting in an insulation build of approximately 0.6 to 0.8 mils.

The properties of the resultant magnet wire are shown in Table I.

#### Example LXII

A conventional FORMVAR magnet wire enamel comprising 16% weight resin in commercially available cresol, phenol and aromatic hydrocarbon solvent as applied to a bare 18 AWG copper magnet wire conductor having no insulation thereon employing dyes in a conventional magnet wire coating tower at 32 meters per minute having temperatures of 450°F., 500°F. and 550°F., respectively, six passes were applied in this manner resulting in an insulation build of approximately 1.8 mils.

300 grams of equal parts of fumed titanium dioxide, fumed alumina and zinc oxide particulate filler having an average particle size of 0.016 microns and an average surface area of 92 square meters per gram was added to 2,580 grams of a conventional FORMVAR magnet wire enamel comprising 16% weight resin in a commercially available cresol, phenol and aromatic hydrocarbon solvent were intimately mixed by stirring at high speed to disperse the particulate filler throughout the enamel. The resultant enamel was then applied to the previously insulated magnet wire conductor having a continuous, concentric and flexible uniform coat of base insulation material thereon by employing dyes and a conventional magnet wire coating tower at 32 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively, 2 passes were applied in this manner to place on the previously insulated conductor the pulsed voltage surge shield of the invention resulting in an insulation build of approximately 0.4 mils.

A conventional NYLON magnet wire enamel comprising 20% resin weight in a phenol, cresol and aromatic hydrocarbon solvent was then applied over the previously insulated conductor having both a continuous, concentric, flexible and uniform coat of base insulation material thereon and the pulsed voltage surge

shield of the invention superimposed thereon by employing dyes and a conventional magnet wire coating tower at 31 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively. Two passes were applied in this manner resulting in an insulation build of approximately 0.6 to 0.8 mils.

5       The properties of the resultant magnet wire are shown in Table I.

### Example LXIII

10       A conventional FORMVAR magnet wire enamel comprising 16% weight resin in commercially available cresol, phenol and aromatic hydrocarbon solvent as applied to a bare 18 AWG copper magnet wire conductor having no insulation thereon employing dyes in a conventional magnet wire coating tower at 32 meters per minute having temperatures of 450°F., 500°F. and 550°F., respectively, six passes were applied in this manner resulting in an insulation build of approximately 1.8 mils.

15       35 grams of WC-426 clay particulate filler having an average particle size of 0.7 microns and a surface area of 13 to about 17 square meters per gram was added to 1,500 grams of a conventional FORMVAR magnet wire enamel comprising 16% weight resin in a commercially available cresol, phenol and aromatic hydrocarbon solvent were intimately mixed by a conventional ball mill to disperse the  
20       particulate filler throughout the enamel. The resultant enamel was then applied to the previously insulated magnet wire conductor having a continuous, concentric and flexible uniform coat of base insulation material thereon by employing dyes and a conventional magnet wire coating tower at 32 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively, 2 passes were applied in  
25       this manner to place on the previously insulated conductor the pulsed voltage surge shield of the invention resulting in an insulation build of approximately 0.4 mils.

30       A conventional amide imide magnet wire enamel comprising 28% weight resin in a N-methyl pyrrolidone and aromatic hydrocarbon solvent was then applied over the previously insulated conductor having both a continuous, concentric, flexible and uniform coat of base insulation material thereon. The pulsed voltage surge shield of the invention superimposed thereon by employing dyes and a conventional magnet wire coating tower at 36 meters per minute, having temperatures of 450°F., 500°F. and 550°F., respectively. Two passes were applied  
35       in this manner resulting in an insulation build of approximately 0.6 to 0.8 mils.

The properties of the resultant magnet wire are shown in Table I.

#### Example LXIV

5 A conventional FORMVAR magnet wire enamel comprising 16% weight resin in commercially available cresol, phenol and aromatic hydrocarbon solvent as applied to a bare 18 AWG copper magnet wire conductor having no insulation thereon employing dyes in a conventional magnet wire coating tower at 32 meters per minute having temperatures of 450°F., 500°F. and 550°F., respectively, six passes were applied in this manner resulting in an insulation build of  
10 approximately 1.8 mils.

100 grams of WC-426 clay particulate filler having an average particle size of 0.7 microns and a surface area of 13 to about 17 square meters per gram was added to 1,500 grams of a conventional FORMVAR magnet wire enamel comprising 16% weight resin in a commercially available cresol, phenol and aromatic hydrocar-  
15 bon solvent were intimately mixed by a conventional ball mill to disperse the particulate filler throughout the enamel. The resultant enamel was then applied to the previously insulated magnet wire conductor having a continuous, concentric and flexible uniform coat of base insulation material thereon by employing dyes and a conventional magnet wire coating tower at 32 meters per minute, having  
20 temperatures of 450°F., 500°F. and 550°F., respectively, 2 passes were applied in this manner to place on the previously insulated conductor the pulsed voltage surge shield of the invention resulting in an insulation build of approximately 0.4 mils.

A conventional NYLON magnet wire enamel comprising 20% resin weight in  
25 a phenol, cresol and aromatic hydrocarbon solvent was then applied over the previously insulated conductor having both a continuous, concentric, flexible and uniform coat of base insulation material thereon and the pulsed voltage surge shield of the invention superimposed thereon by employing dyes and a conventional magnet wire coating tower at 31 meters per minute, having  
30 temperatures of 450°F., 500°F. and 550°F., respectively. Two passes were applied in this manner resulting in an insulation build of approximately 0.6 to 0.8 mils.

The properties of the resultant magnet wire are shown in Table I.

The specific test equipment utilized includes a laboratory oven in which a sample cell is positioned. The sample cell is connected in series to a pulse  
35 generator and a signal conditioner. The signal conditioner and the pulse generator

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are connected to an oscilloscope. A bipolar power supply is connected in parallel to the sample cell and the oscilloscope between the pulse generator and the signal conditioner. In the specific test facility utilized, peak to peak voltage could be varied from 1,000 to 5,000 volts, repetitive frequency could be varied from 60 Hz to 20 kHz, and rise time of the pulse could be varied from 60 nano seconds to 250 nano seconds for a pulse of 5,000 volts.

A standard twisted wire pair was used for each test. The twisted wire pair was mounted in the sample cell. 18 AWG wire was used in each test. Each wire pair was twisted 8 revolutions. The insulation was stripped off at each end of the twisted pair. The remaining conductor portion was used as an electrode. One end of the wire was connected to the positive output of the pulse generator, and the other end to the negative output of the pulse generator. The other side of the twisted pair were kept apart.

The magnet wire made in accordance with Examples I through LXIV hereinabove were tested in accordance with the pulsed voltage surge resistant magnet wire test in which a twisted pair of insulated conductors of the invention were subjected to a pulsed wave at a frequency of 20 kHz at temperatures ranging from 30°C. to 90°C. having a 50% duty cycle as shown in Table I. All of the data reported was at a rate of rise of 83 kV per microsecond. The electrical stress applied to the twisted pair ranged from 0.7 to 1 kV per mil. The extended life of the pulsed voltage surge resistant magnet wire is shown to be ten-fold over the magnet wire without the pulsed voltage surge resistant shield of the invention.

The improved magnet wire of the invention provides an improved magnet wire for use in such AC motors which has increased resistance to insulation degradation caused by pulsed voltage surges. The improved magnet wire of the invention provides an improved magnet wire which can withstand voltage surges approaching 3,000 volts having rates of rise of about 1.0 kV per micro second to about 100 kv per micro second temperatures for short periods of time of about 300°C. after the insertion of the windings in a motor rotor and stator over anticipated lifetime of the motor. The improved magnet wire of the invention provides an improved magnet wire which will pass all of the dimensional ANSI/NEMA magnet wire standards MW1000 and in addition NEMA MG1-Parts 30 and 31 for constant speed motors on a sinusoidal bus and general purpose motors used with variable frequency controls, or both, and definite purpose inverter fed motors, respectively. The improved magnet wire of the invention provides an

improved magnet wire which meets all of the performance characteristics desired by motor manufacturers for stator and rotor windings for use under corona discharge conditions.

- 5 While there have been described above principles of the invention in connection with a specific magnet wire insulating materials and specific particulate fillers, it is to be clearly understood that this description is made only by way of example, and not as a limitation of the scope of the invention.

TABLE I

Example	I	II	III	IV	V	VI
Speed - mpm	34	34	34	34	34	34
Surface rating	1.1	1.2	1.1	1.3	1.1	1.3
Insulation build - mils	3.0	2.9-3.0	3.0-3.1	3.0	3.0	3.0-3.1
Elongation - %	41	42	40	43	42	40
Mandrel Flex	30% 1X OK	35% 3X OK	25% 5X OK	20% 1X OK	30% 3X OK	20% 5X OK
Snap	OK	OK	OK	OK	OK	OK
Snap Flex	OK 1X	OK 1X	OK 3X	OK 1X	OK 3X	OK 3X
Dielectric Breakdown - V	12,220	11,730	10,820	12,100	11,680	10,470
Time to Fail 20 kHz, 2 kV, 90°C., 50% Duty Cycle, seconds	>40,000	>60,000	>70,000	>40,000	>60,000	>70,000
Size, AWG	18	18	18	18	18	18
Conductor	Copper	Copper	Copper	Copper	Copper	Copper

Example	VII	VIII	IX	X	XI	XII
Speed - mpm	34	34	34	34	34	34
Surface rating	1.1	1.1	1.2	1.2	1.1	1.1
Insulation build - mils	3.0	2.9-3.0	3.0-3.1	3.0	2.9-3.0	3.0-3.1
Elongation - %	42	40	41	41	42	40
Mandrel Flex	30% 1X OK	30% 3X OK	30% 5X OK	1X OK	1X OK	2X OK
Snap	OK	OK	OK	OK	OK	OK
Snap Flex	OK 1X	OK 3X	OK 6X	OK 1X	OK 1X	OK 2X
Dielectric Breakdown - V	11,809	11,250	10,250	11,980	12,520	10,580
Time to Fail 20 kHz, 2kV, 90°C., 50% Duty Cycle, seconds	>40,000	>60,000	>70,000	566 80°C.	666 80°C.	>40,000
Size, AWG	18	18	18	18	18	18
Conductor	Copper	Copper	Copper	Copper	Copper	Copper

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TABLE I (Continued)

Example	XIII	XIV	XV	XVI	XVII	XVIII
Speed - mpm	34	34	34	34	34	34
Surface rating	1.2	1.1	1.3	1.1	1.1	1.3
Insulation build - mils	2.9-3.0	3.0	2.9-3.0	3.0-3.1	3.0	3.0
Elongation - %	42	41	40	40	40	40
Mandrel Flex	30% 4X OK	35% 5X OK	30% 6X OK	25% 5X OK	30% 5X OK	30% 6X OK
Snap	OK	OK	OK	OK	OK	OK
Snap Flex	OK 4X	OK 6X	OK 7X	OK 3X	OK 6X	OK 6X
Dielectric Breakdown - V	10,980	11,250	11,000	10,400	11,860	10,750
Time to Fail 20 kHz, 2kV, 90°C., 50% Duty Cycle, seconds	>50,000	>70,000	>80,000	>30,000	>30,000	>30,000
Size, AWG	18	18	18	18	18	18
Conductor	Copper	Copper	Copper	Copper	Copper	Copper

Example	XIX	XX	XXI	XXII	XXIII	XXIV
Speed - mpm	34	34	16	16	16	16
Surface rating	1.1	1.1	1.3	1.2	1.2	1.3
Insulation build - mils	3.0	3.0	3.0	3.0	3.0	3.0
Elongation - %	40	41	42	40	41	40
Mandrel Flex	20% 1X OK	20% 1X OK	20% 1X OK	20% 3X OK	20% 5X OK	20% 1X OK
Snap	OK	OK	OK	OK	OK	OK
Snap Flex	OK 5X	OK 5X	OK 1X	OK 3X	OK 6X	OK 1X
Dielectric Breakdown - V	10,580	8,100	5,850	6,100	7,480	6,375
Time to Fail 20 kHz, 2kV, 90°C., 50% Duty Cycle, seconds	>3,000	>4,000	>6,000	>12,000	>20,000	>4,000
Size, AWG	18	18	18	18	18	18
Conductor	Copper	Copper	Copper	Copper	Copper	Copper

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TABLE I (Continued)

Example	XXV	XXVI	XXVII	XXVIII	XXIX	XXX
Speed - mpm	16	16	16	16	16	16
Surface rating	1.3	1.2	1.2	1.3	1.2	1.3
Insulation build - mils	3.0	2.9-3.0	3.0	3.0	3.0	3.1
Elongation - %	41	42	40	42	42	40
Mandrel Flex	30% 3X OK	30% 5X OK	30% 1X OK	30% 3X OK	30% 5X OK	30% 2X OK
Snap	OK	OK	OK	OK	OK	OK
Snap Flex	OK 3X	OK 5X	OK 1X	OK 3X	OK 6X	OK 2X
Dielectric Breakdown - V	7,180	7,360	6,340	6,120	6,820	5,950
Time to Fail 20 kHz, 2kV, 90°C., 50% Duty Cycle, seconds	>12,000	>20,000	>4,000	>12,000	>20,000	>40,000
Size, AWG	18	18	18	18	18	18
Conductor	Copper	Copper	Copper	Copper	Copper	Copper

Example	XXXI	XXXII	XXXIII	XXXIV	XXXV	XXXVI
Speed - mpm	16	16	16	16	16	16
Surface rating	1.2	1.3	1.2	1.2	1.3	1.3
Insulation build - mils	3.0	3.0	3.0	3.0	3.0	3.0
Elongation - %	40	40	41	42	40	40
Mandrel Flex	30% 3X OK	30% 5X OK	30% 1X OK	30% 1X OK	30% 3X OK	30% 5X OK
Snap	OK	OK	OK	OK	OK	OK
Snap Flex	OK 3X	OK 6X	OK 1X	OK 1X	OK 3X	OK 5X
Dielectric Breakdown - V	6,750	5,650	6,100	5,850	6,550	5,700
Time to Fail 20 kHz, 2kV, 90°C., 50% Duty Cycle, seconds	>60,000	>70,000	94	96	>25,000	>25,000
Size, AWG	18	18	18	18	18	18
Conductor	Copper	Copper	Copper	Copper	Copper	Copper

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TABLE I (Continued)

Example	XXXVII	XXXVIII	XXXIX	XL	XLI	XLII
Speed - mpm	16	16	16	34	34	34
Surface rating	1.3	1.2	1.2	1.3	1.1	1.2
Insulation build - mils	3.0	3.0	3.0	3.0	3.0	2.9-3.0
Elongation - %	40	42	41	40	46	46
Mandrel Flex	30% 6X OK	30% 6X OK	30% 6X OK	30% 2X OK	30% OK	30% OK
Snap	OK	OK	OK	OK	OK	OK
Snap Flex	OK 6X	OK 6X	OK 6X	OK 2X	OK 3X	OK 3X
Dielectric Breakdown - V	5,650	6,700	6,560	6,650	11,300	10,900
Time to Fail 20 kHz, 2kV, 90°C., 50% Duty Cycle, seconds	>25,000	>3,000	>6,000	>40,000	>60,000	>70,000
Size, AWG	18	18	18	18	18	18
Conductor	Copper	Copper	Copper	Copper	Copper	Copper

Example	XLIII	XLIV	XLV	XLVI	XLVII	XLVIII
Speed - mpm	34	34	34	32	32	32
Surface rating	1.1	1.1	1.1	1.1	1.1	1.1
Insulation build - mils	3.0	3.0	3.0	3.0	3.0	3.0
Elongation - %	46	46	46	46	35	35
Mandrel Flex	30% OK	30% 2X OK	30% 4X OK	30% 5X OK	30% 1X OK	30% 1X OK
Snap	OK	OK	OK	OK	OK	OK
Snap Flex	OK 3X	OK 2X	OK 4X	OK 5X	OK 1X	OK 1X
Dielectric Breakdown - V	10,190	11,200	11,920	10,650	10,750	10,560
Time to Fail 20 kHz, 2kV, 90°C., 50% Duty Cycle, seconds	>40,000	>60,000	>70,000	>40,000	>55,000	>75,000
Size, AWG	18	18	18	18	18	18
Conductor	Copper	Copper	Copper	Copper	Copper	Copper

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TABLE I (Continued)

Example	XLIX	L	LI	LII	LIII	LIV
Speed - mpm	32	32	32	32	32	32
Surface rating	1.1	1.1	1.1	1.1	1.1	1.1
Insulation build - mils	3.0	3.0	3.0	3.0	3.0	3.0
Elongation - %	35	35	40	40	40	40
Mandrel Flex	30% 2X OK	30% 2X OK	30% 1X OK	30% 1X OK	30% 1X OK	30% 1X OK
Snap	OK	OK	OK	OK	OK	OK
Snap Flex	OK 2X	OK 2X	OK 1X	OK 1X	OK 1X	OK 1X
Dielectric Breakdown - V	14,300	13,750	10,680	10,120	10,980	10,350
Time to Fail 20 kHz, 2kV, 90°C., 50% Duty Cycle, seconds	>40,000	>55,000	>70,000	>40,000	>55,000	>70,000
Size, AWG	18	18	18	18	18	18
Conductor	Copper	Copper	Copper	Copper	Copper	Copper

Example	LV	LVI	LVII	LVIII	LIX	LX
Speed - mpm	32	32	32	32	32	32
Surface rating	1.1	1.1	1.1	1.1	1.1	1.1
Insulation build - mils	3.0	3.0	3.0	3.0	3.0	3.0
Elongation - %	40	40	40	40	40	40
Mandrel Flex	OK 1X	OK 1X	OK 1X	OK 1X	OK 1X	OK 1X
Snap	OK	OK	OK	OK	OK	OK
Snap Flex	OK 1X	OK 1X	OK 1X	OK 1X	OK 1X	OK 1X
Dielectric Breakdown - V	10,750	10,975	10,870	10,970	11,570	11,280
Time to Fail 20 kHz, 2kV, 90°C., 50% Duty Cycle, seconds	>40,000	>20,000	>70,000	380	461	>30,000
Size, AWG	18	18	18	18	18	18
Conductor	Copper	Copper	Copper	Copper	Copper	Copper

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TABLE I (Continued)

Example	LXI	LXII	LXIII	LXIV		
Speed - mpm	32	32	32	32		
Surface rating	1.1	1.1	1.1	1.1		
Insulation build - mils	3.0	3.0	3.0	3.0		
Elongation - %	40	40	40	40		
Mandrel Flex	OK 1X	OK 1X	OK 1X	OK 1X		
Snap	OK	OK	OK	OK		
Snap Flex	OK 1X	OK 1X	OK 1X	OK1X		
Dielectric Breakdown - V	11,200	10,960	11,200	10,100		
Time to Fail 20 kHz, 2kV, 90°C., 50% Duty Cycle, seconds	>30,000	>30,000	>30,000	>5,000		
Size, AWG	18	18	18	18		
Conductor	Copper	Copper	Copper	Copper		

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## WHAT IS CLAIMED IS:

1. A pulsed voltage surge resistant magnet wire comprising a conductor, a continuous and concentric and flexible uniform coat of insulation material superimposed on said conductor, an essentially continuous and concentric and uniform pulsed voltage surge shield superimposed on said coat, said shield comprising a continuous, concentric and essentially uniform layer of particulate material and binder overlaying said coat of insulation material, said continuous and concentric and flexible and uniform top coat of insulation material superimposed on said shield.
2. The magnet wire of Claim 1 wherein said insulation material is chosen from the group of polymeric materials consisting of polyamides, polyimides, polyamideimides, polyesters, polyesterimide, polyetherimides, polyesteramideimides, polyamide esters, polyimide esters, polyaryl sulfones, polyvinyl acetals, polyurethanes, epoxies, acrylics and combinations thereof.
3. The magnet wire of Claim 1 wherein said particulate material has a size from about 0.005 to about 1.0 microns.
4. The magnet wire of Claim 1 wherein said particulate material is chosen from the group of materials consisting of metallic oxides, naturally occurring clays, and mixtures thereof.
5. The magnet wire of Claim 1 wherein said particulate material is chosen from the group of metal oxides consisting of titanium dioxide, alumina, silica, zirconium oxide, zinc oxide, iron oxide and combinations thereof.
6. The magnet wire of Claim 4 wherein said clays are chosen from the group consisting of POLYFIL 90 clay, WC-426 clay, TRANSLINK 77 clay, ASP ULTRAFINE clay, ECC-TEX clay and combinations thereof.
7. The magnet wire of Claim 1 wherein said conductor is chosen from the group consisting of copper and aluminum conductors, said magnet wire meets all of the dimensional specifications of the ANSI/NEMA MW1000 standards.

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8. The magnet wire of Claim 1 wherein said particulate material is dispersed throughout said shield.

5 9. The magnet wire of Claim 1 wherein said particulate material is present in said shield from about 1% to about 65% by weight of said shield.

10 10. The magnet wire of Claim 1 wherein said particulate material is a metallic oxide having a particle size from about 0.01 to about 0.8 microns in an amount of less than 20% weight of said shield.

11. The magnet wire of Claim 1 wherein said binder is chosen from the group of polymeric materials consisting of polyamides, polyimides, polyamideimides, polyesters, polyesterimide, polyetherimides, 15 polyesteramideimides, polyamide esters, polyimide esters, polyaryl sulfones, polyvinyl acetals, polyurethanes, epoxies, acrylics and combinations thereof.

12. A pulsed voltage surge resistant magnet wire comprising a conductor, a continuous and concentric and flexible uniform coat of base insulation material 20 superimposed on said conductor, an essentially continuous and concentric and uniform pulsed voltage surge shield overlaying said coat, said shield having therein a binder and an effective amount of a particulate material, said shield being superimposed on said coat, said particulate of said shield being from about .005 microns to about 1 micron in size, and a continuous and concentric and flexible and 25 uniform top coat of insulation material superimposed on said shield.

13. The magnet wire of Claim 12 wherein said particulate material has a size from about 0.01 to about 0.8 microns.

30 14. The magnet wire of Claim 12 wherein said particulate material is chosen from the group of materials consisting of metallic oxides, naturally occurring clays and mixtures thereof.

15. The magnet wire of Claim 12 wherein said particulate material is chosen from the group of metal oxides consisting of titanium dioxide, alumina, silica, zirconium oxide, zinc oxide, iron oxide and combinations thereof.

5 16. The magnet wire of Claim 14 wherein said clays are chosen from the group consisting of POLYFIL 90 clay, WC-426 clay, TRANSLINK 77 clay, ASP ULTRAFINE clay, ECC-TEX clay and combinations thereof.

10 17. The magnet wire of Claim 12 wherein said conductor is chosen from the group consisting of copper and aluminum conductors, said magnet wire meets all of the dimensional specifications of the ANSI/NEMA MW1000 standards.

15 18. The magnet wire of Claim 12 wherein said shield comprises said particulate material present in said binder from about 1% to about 65% by weight of said shield.

20 19. The magnet wire of Claim 12 wherein said particulate material is a metallic oxide having a particle size from about 0.01 to about 0.8 in an amount of less than 20% weight of said shield.

25 20. The magnet wire of Claim 11 wherein said insulation material is chosen from the group of polymeric materials consisting of polyamides, polyimides, polyamideimides, polyesters, polyesterimide, polyetherimides, polyesteramideimides, polyamide esters, polyimide esters, polyaryl sulfones, polyvinyl acetals, polyurethanes, epoxies, acrylics and combinations thereof.

30 21. A magnet wire for use in PWM, variable frequency and/or inverter driven motors comprising a conductor, a continuous and concentric and flexible uniform coat of insulation material superimposed on said conductor, an essentially continuous and concentric and uniform pulsed voltage surge shield superimposed on said coat, said shield comprising a continuous, concentric and essentially uniform layer of particulate material and binder overlaying said coat of insulation material, and a continuous and concentric and flexible and uniform top coat of insulation material superimposed on said shield.

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22. The magnet wire of Claim 21 wherein said insulation material is chosen from the group of polymeric materials consisting of polyamides, polyimides, polyamideimides, polyesters, polyesterimide, polyetherimides, polyesteramideimides, polyamide esters, polyimide esters, polyaryl sulfones, polyvinyl acetals, polyurethanes, epoxies, acrylics and combinations thereof.

23. The magnet wire of Claim 21 wherein said particles have a size from about 0.005 to about 1.0 microns.

24. The magnet wire of Claim 21 wherein said particulate material is chosen from the group of materials consisting of metallic oxides, naturally occurring clays, and mixtures thereof.

25. The magnet wire of Claim 21 wherein said particulate material is chosen from the group of metal oxides consisting of titanium dioxide, alumina, silica, zirconium oxide, zinc oxide, iron oxide and combinations thereof.

26. The magnet wire of Claim 24 wherein said clays are chosen from the group consisting of POLYFIL 90 clay, WC-426 clay, TRANSLINK 77 clay, ASP ULTRAFINE clay, ECC-TEX clay and combinations thereof.

27. The magnet wire of Claim 21 wherein said conductor is chosen from the group consisting of copper and aluminum conductors, said magnet wire meets all of the dimensional specifications of the ANSI/NEMA MW1000 standards.

28. The magnet wire of Claim 21 wherein said particulate material is dispersed throughout said shield.

29. The magnet wire of Claim 21 wherein said particulate material is present in said shield from about 1% to about 65% by weight of said shield.

30. The magnet wire of Claim 21 wherein said particulate filler material is a metallic oxide having a particle size from about 0.01 to about 0.8 microns in an amount of less than 20% weight of said shield.

31. The magnet wire of Claim 21 wherein said binder is chosen from the group of polymeric materials consisting of polyamides, polyimides, polyamideimides, polyesters, polyesterimide, polyetherimides, polyesteramideimides, polyamide esters, polyimide esters, polyaryl sulfones, polyvinyl acetals, polyurethanes, epoxies, acrylics and combinations thereof.

32. A magnet wire for use in PWM, variable frequency and/or inverter driven motors comprising a conductor, a continuous and concentric and flexible uniform coat of base insulation material superimposed on said conductor, and an essentially continuous and concentric and uniform pulsed voltage surge shield overlaying said coat, said shield having therein a binder and an effective amount of a particulate material, said shield being superimposed on said coat, said particulate of said shield being from about .005 microns to about 1 micron in size, and a continuous and concentric and flexible and uniform top coat of insulation material superimposed on said shield.

33. The magnet wire of Claim 32 wherein said particulate material has a size from about 0.01 to about 0.8 microns.

34. The magnet wire of Claim 32 wherein said particulate material is chosen from the group of materials consisting of metallic oxides, naturally occurring clays and mixtures thereof.

35. The magnet wire of Claim 32 wherein said particulate material is chosen from the group of metal oxides consisting of titanium dioxide, alumina, silica, zirconium oxide, zinc oxide, iron oxide and combinations thereof.

36. The magnet wire of Claim 34 wherein said clays are chosen from the group consisting of POLYFIL 90 clay, WC-426 clay, TRANSLINK 77 clay, ASP ULTRAFINE clay, ECC-TEX clay and combinations thereof.

37. The magnet wire of Claim 32 wherein said conductor is chosen from the group consisting of copper and aluminum conductors, said magnet wire meets all of the dimensional specifications of the ANSI/NEMA MW1000 standards.



38. The magnet wire of Claim 32 wherein said shield comprises said particulate material present in insulation material from about 1% to about 65% by weight of said shield.

5 39. The magnet wire of Claim 32 wherein said particulate material is a metallic oxide having a particle size from about 0.01 to about 0.8 in an amount of less than 20% weight of said shield.

10 40. The magnet wire of Claim 32 wherein said insulation material is chosen from the group of polymeric materials consisting of polyamides, polyimides, polyamideimides, polyesters, polyesterimide, polyetherimides, polyesteramideimides, polyamide esters, polyimide esters, polyaryl sulfones, polyvinyl acetals, polyurethanes, epoxies, acrylics and combinations thereof.

15 41. A magnet wire having a pulse voltage surge shield superimposed thereon, said shield including a binder and an effective amount of a particulate material to increase said pulsed voltage surge resistance of said insulation material by at least tenfold in comparison testing at 20 kHz, 0.7 to 1 kV per mil, 50% duty cycle, from about 30° to 130° C., and a rate of rise of about 83 kV per microsecond,  
20 said material having a particulate size ranging from about 0.005 to about 1 micron.

42. A pulsed voltage surge resistant magnet wire comprising a conductor, a continuous and concentric and flexible and uniform coat of base insulation material superimposed on said conductor, and an essentially continuous and  
25 concentric and uniform pulse voltage surge shield overlaying said coat of base insulation material.

43. A magnet wire for use in PWM, variable frequency and/or inverter driven motors having a pulse voltage surge shield superimposed thereon, said  
30 shield including a binder and an effective amount of a particulate material to increase said pulsed voltage surge resistance of said insulation material by at least tenfold in comparison testing at 20 kHz, 0.7 to 1 kV per mil, 50% duty cycle, from about 30° to 130° C., and a rate of rise of about 83 kV per microsecond, said material having a particulate size ranging from about 0.005 to about 1 micron.

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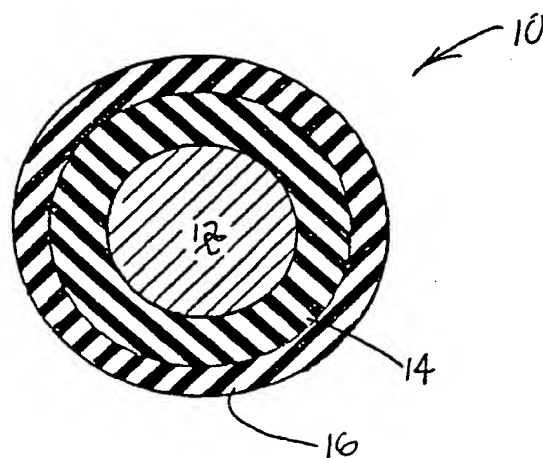


FIG. 1

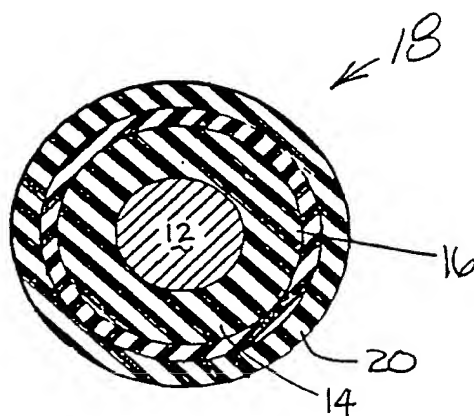


FIG. 2

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## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US96/08778

## A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :D02G 3/00

US CL :428/375

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : Please See Extra Sheet.

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2,935,427 A (HALL ET AL) 03 May 1960 (03.05.60), see column 1, lines 59-66, column 2, lines 18-38 and 70-71 and column 4, lines 7-8.	1-43
Y	US 4,716,079 A (SANO ET AL) 29 December 1987 (29.12.87), see abstract, Figure 1 and column 1, line 46 through column 2, line 40.	1-43



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:	*T	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
*A* document defining the general state of the art which is not considered to be of particular relevance	*X*	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
*E* earlier document published on or after the international filing date	*Y*	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
*L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	*Z*	document member of the same patent family
*O* document referring to an oral disclosure, use, exhibition or other means		
*P* document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search

12 SEPTEMBER 1996

Date of mailing of the international search report

27 SEP 1996

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Form PCT/ISA/210 (second sheet)(July 1992)\*

# INTERNATIONAL SEARCH REPORT

International application No.

PCT/US96/08778

## B. FIELDS SEARCHED

Minimum documentation searched

Classification System: U.S.

428/375, 372, 378, 379, 383, 384, 386, 387, 389; 174/110A, 110SR, 110N, 110PM, 110E  
174/102SR, 127

Form PCT/ISA/210 (extra sheet)(July 1992)\*